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Spring Clean-Up Campaign

FROM every part of the country has come commendation, in recent years, of the spring clean-up campaigns. They have become annual features not only in villages and towns, but even in the big cities. New York and Philadelphia, among other metropolitan centers, have conducted successful campaigns. The object of this note is not to point out their advantages—for they are already well recognized—but to urge city engineers and other municipal officials to begin the work of organization and preparation for their campaigns immediately. Clean-up week is generally set late in April or early in May. If plans are undertaken now there is plenty of time to decide upon ways and means and to perfect the necessary machinery to bring about a successful result.

Spoiled by Typography

ELSEWHERE in these columns is comment on the good-roads pamphlet issued by one of the motor-truck companies. In striking contrast with the attractive way in which that pamphlet has been prepared is a booklet entitled "Good Roads Bulletin for Illinois Public Schools," which the state superintendent of public instruction of that state is distributing. It contains good material—articles with the following titles: Good Roads and Good Schools, Pertinent Points about Roads, Construction and Maintenance of Earth Roads, and Roadside Improvement. Unfortunately, however, those who prepared the booklet typographically did not have a keen appreciation of the methods of presenting printed matter effectively. The type is small, the illustrations few, giving an impression of heaviness that will repel the pupil. It would have cost but little more to have presented the material in most attractive form. To use the language of business, the object of the pamphlet is to "sell" the good-roads idea to the pupils of the schools of Illinois. Selling and advertising methods and standards should, therefore, have been in mind. Moreover, the desired effect would have been produced without lessening the technical excellence of the material presented.

For Civic Beauty

ATTENTION was called in these columns some time ago to the agitation, in which engineers were participating, to prevent the defacement of parks in Washington and in New York City. At Washington the Government proposed to erect a power-house with tall stacks in Potomac Park—in such a location as to be a blot on landscape in which the Washington Monument is a prominent feature. At New York protest was directed against the placing of a pumping station in Morningside Park. It is gratifying to note that engineers, through the American Institute of Consulting Engineers, have taken an active part in both of these agitations. It is reported that the Morningside difficulty is on the way to a solution which will preserve the park unmarred. At Washington progress seems to be slower. The interests allied against the proposed location of the power plant have now made a strong appeal through an elaborate pamphlet. By argument and pictures it shows exactly what the effect of the power-house will be on various aspects of the Washington Monument and the Capitol dome. The pamphlet is most convincing. Certainly the voice of the people the country over who are anxious to make of Washington one of the most beautiful capitals of the world should force the Treasury Department to change the location to some unobjectionable site. It is urged that engineering societies throughout the country take up this matter and pass suitable resolutions. Copies of the pamphlet can be secured through the American Institute of Architects at Washington. The question is a national one, and engineers should urge a solution that will be compatible with the dignity of the nation's capital.

Uncle Sam's Purse

SENATOR NEWLANDS has introduced a bill in the U. S. Senate which would appropriate to each land-grant college the sum of $15,000 annually for the support of an engineering experiment station. It is needless to say that the Engineering Record heartily favors the establishment of such stations, not only in land-grant but in other colleges as well. It is not in sympathy, however, with a scheme which just opens another avenue into Uncle Sam's purse, without any special warrant for the government bearing the burden. The situation is different to-day than when the Morrill act, which gave government support to colleges of agriculture and mechanic arts, was passed. In 1862 the middle western states were poor, the need for scientific education was little appreciated and a stimulus was necessary to get the states to embark on the work of higher education. Now conditions have changed and there is no state which can not support magnificently colleges and universities of the highest order. The engineering experiment station is a worthy institution. In the opinion of the Engineering Record, however, the states should take the initiative and furnish the funds themselves. The least the Land Grant College Engineering Association, which is backing the legislation, might do is to agree that the states would put up dollar for dollar what the government does. Even then the Engineering Record would favor such government participation only if the work which would be done under the appropriation would be subject to the approval of the central government. Only under such supervision could there be hope that duplication and the frittering away of time and money on subjects of little or no value would be avoided.

Trailers for Motor Trucks

ELSEWHERE in this issue considerable space is given to an investigation made by Mr. Pennington of the Troy Wagon Works Company as to the utility of its trailers in connection with motor trucks. Scientific analysis on the part of manufacturers, in lieu of loose generalities by uninformed salesmen, is much to be encouraged. The efforts of the Troy company are in this direction. The company does not claim that trailers can be used wherever motor trucks are employed. Moreover, it contends, and the contention seems to be well founded, that what it has learned with respect to its own trailers cannot be applied to an ordinary wagon, not especially designed for trailer service. The main fruits of the investigation are the diagram by which the non-technical man can find out how much his truck can haul; the table of resistances for various classes of road; and the combination of the two to determine the precise limits of the field of usefulness of the truck. The Engineering Record believes that the analysis has shown again, what ought to be obvious to all who have stopped to think about the matter and compare highway transportation with rail transportation, that the trailer is a natural complement to the motor truck. Whether the tractor will ever become merely a highway locomotive, leaving the whole load to the trailers, is yet to be seen. It may come to pass. Certainly efficiency demands that the capacity of the motor truck be measured by what it can haul, and not solely by what it can carry on its back.

Complete Specifications

INDIANA engineers and architects must henceforth specify exactly what they mean and furnish bidders on state work with plans which are complete and accurate to the last detail, if the rules published March 6 by the Board of Accounts of that state, governing the letting of public-building contracts, are to be taken at their face value. These rules call the attention of public officials to the fact that it is against the law in that state for bidders to furnish, or be compelled to furnish, any part of the design of the completed work. The design must be ready before bids are asked, and must be so well done that changes in plans, which are the cause of an evasion of the law by precluding competition on the changed items, are reduced to the smallest possible proportions. The rules further point out that the engineer or architect cannot be made the final judge of disputes arising over the contract. The law does not permit the delegation to the engineer of those powers of public officials under which disputes about contracts and final acceptance of work may be adjusted. Presumably, if a contractor cannot reach an agreement with the public officials, the courts must be the arbiter. This feature of the rules may cause delay and loss, but, at least, it is pleasing to see the principle sustained that neither owner nor contractor should be able to impose on the other party through the agency of an engineer. The engineer is an employee of one of the parties to the contract, and should not be obliged to decide as an arbiter matters involving by indirection his own interests. The Indiana Board of Accounts has made a step in the right direction, and it is only to be regretted that all of our public contracts are not let on as fair a basis as that laid down in these rules.

Architect vs. Engineer

LITTLE attention, apparently, has been given to the report rendered by a committee of the American Society of Civil Engineers to the Board of Direction on Jan. 17 with reference to the licensing of architects. The committee reported that in several states there are now laws governing the practice of architecture, and that similar legislation has been actively proposed in nine other states. All of these laws, enforced and proposed, make illegal the construction of buildings except upon the plans and specifications prepared by licensed architects. In other words, all of them would impose serious hardships on the engineering profession. In Illinois, structural engineers are now licensed for the sole purpose of counteracting the architect's licensing law. Without a doubt similar legislation is necessary in the other states where architecture is now a controlled profession, while the same sort of action will be needed in the case of every state which puts the practice of architecture under government control.

The committee of the society urged that a joint committee be formed between all of the national engineering societies and that the co-operation of the American Institute of Architects be requested in an endeavor to find some plan which may further the mutual esteem and co-operation of the two professions. Pending the results of these steps, the committee further recommended that the matter be referred to the local associations, with the request that they take organized action in opposition to the enactment of any law licensing the practice of architecture, should such legislation be proposed.

The subject is a very important one and requires the active interest of the engineering profession. Only by vigilance and vigorous action will the architects be prevented from causing in other states the hardships upon engineers which prevailed for so many years in Illinois.

Without a doubt the best plan would be to secure co-operation with the American Institute of Architects to the end that both engineers' and architects' licensing laws be kept off the statute books, and be repealed where now in force. As this journal has long held, such licenses do not make for the safety and welfare of the public. That can only be provided for by examining the work of the engineer and the architect and not the individual.

Unless co-operative action is brought about, there is likely to be a serious breach between the two professions—architecture and engineering—a condition much to be deplored.

In the Interest of Good Roads

SO KEEN is now the appreciation of the need for good roads and of the bearing of good roads on a community's prosperity, that one expects all classes to co-operate in highway propaganda. Then, too the extent to which various interests have participated in good-roads campaigns is fairly well known. There is less appreciation, however, of some of the yeoman service rendered by individuals and by certain corporations. In many cases—possibly in all but few—the motive has been in part selfish, but so long as the selfish motive is subordinated, one can heartily commend the work. There are cases, of course, in which ill-advised appropriations and expenditures have resulted largely from the work of corporations who cared not for the public so long as they secured fat contracts. But these are not referred to here.

An example of the higher type of promotion is that carried on by the Garford Motor Truck Company, largely through the energy and vision of its sales manager, S. M. Williams. In fact, so much time has he given to propaganda work that he sometimes has to ask himself whether he is in the truck or the good-roads business. The connection, however, is very close. Possibly the greatest present use for motor trucks is on paved city streets, but the opportunity of the future lies in the development of traffic lines radiating out into the country and connecting nearby communities. Manifestly the greatest foe to such traffic development is poor roads. That accounts primarily for the interest of a motor-truck salesman in the good-roads propaganda. At the same time, the campaign has had, and will have, a great public benefit.

The basis of the company's activity is a 16-page, 6 x 9-in. pamphlet entitled, "Roads—Their Influence Upon Economic and Social Conditions." It presents briefly the effect of good and of bad roads on a community, emphasizing the statements with striking photographs of good and poor highways and of the farming communities always associated with the two classes. These pamphlets have been distributed by the hundreds of thousands—have been mailed to individuals by the company, have been sent to granges and farmers' institutes, have been used as campaign literature in connection with bond-issue elections. No particular type of road is advocated—merely improved roads—leaving the local authorities the determination of the suitable type.

The result of such propaganda cannot but be good. The company deserves to be commended for its work, even though it receive, through increased business, an ample reward for the financial outlay its efforts have entailed.

Changing Horses in Midstream

A NEW YORK STATE legislative committee, seemingly actuated by a desire to organize political opposition to the governor of the state, has threatened to introduce legislation throwing control of New York City's subway construction from the Public Service Commission for the First District to the city's Board of Estimate. This journal does not contend that to have the city in direct control of its own rapid-transit construction is not preferable, as an abstract proposition, to state control. There are two maxims that suggest the attitude to be taken toward a change at the present time. One is to the effect that changing horses in midstream is apt to prove disastrous, and the other, drawn from military life, asserts that a poor plan vigorously carried out is preferable to the best of plans if the latter is to be changed while the army is trying to execute it. With a "home-rule" sop thrown to the New York delegation, the estimable legislative committee would, for the sole apparent purpose of discrediting a disliked governor, disrupt or replace an engineering organization that has reached a good state of efficiency after years of hard work, and turn its $325,000,000 job, with millions outstanding in unfinished contracts, over to five city officials who already have their hands full.

The committee justifies this stand by pointing to evidence which it interprets as reflecting on the integrity of past, present and proposed members of the commission and of several of its engineers. To the engineering profession such allegations as that a $2,000,000 bribe fund was concealed in 15 per cent profit on the contract for rebuilding the Manhattan elevated lines are more productive of smiles than of credence. Although the committee objects personally to Travis H. Whitney, the confirmation of whose appointment was demanded by Oscar S. Straus as a condition of his continuing to head the commission, and although it disapproves of D. L. Turner, deputy chief engineer, for whom it would be enough to say that he also is supported by Mr. Straus, such reasons scarcely justify the committee in throwing the subway work into confusion by the proposed change. Neither would the committee be justified in such a course by any dereliction of duty on the part of former public service commissioners. Save for political intrigue, the press and public would with fullest confidence support the new commission in carrying the work to a rapid and successful conclusion. If the press and the public permit the consummation of this political trick, they will connive at a staggering blow to engineering efficiency on public works.

South American Field Begins to Materialize

SINCE the outbreak of the European war this journal has been pointing out editorially the possibilities that are offered the engineer and contractor from the United States in the countries to the south of us. With the ratification by the Uraguayan Senate of a large waterworks and sewerage system contract, which is one of the largest individual contracts for municipal improvements ever entered into by an American concern outside of the United States, it would appear that these possibilities are beginning to materialize. Details of the contract will be found on page 431.

There is no reason why such reports from now on should be few and far between. The possibilities exist. Many large cities in the Latin countries are in pressing need of municipal improvements. The fuel problem in some of the countries is so acute that the time would seem ripe to discuss hydroelectric developments. There is need of railroads and harbor and river improvements. Almost daily we read of valuable agricultural products being endangered by weather conditions due to lack of warehouses. There is need of cold-storage and meat-packing plants. A sugar mill erected to-day would pay for itself in a short time, due to the unprecedented prices being obtained for the product.

With the proper effort and the facilities, contractors from the United States should find plenty to do in South and Central America, and the West Indies. In some cases the projects may have to be suggested, and the people of the country educated up to an appreciation of the expediency of undertaking them. In most cases the work will have to be financed, but fortunately we are in the strongest financial position in our history. The obstacles, then, are not insurmountable. Similar problems have been dealt with on innumerable occasions in the United States. With proper personnel they can be handled just as successfully in other countries. The field is there. What it will amount to depends on how it is developed.

Liability of Manufacturers for Defects in Materials

LAWYERS have been awaiting with considerable interest the outcome of a case, just decided by the New York Court of Appeals, in which was involved the responsibility of manufacturers for injuries resulting from defective materials. Heretofore the rule followed by New York and other state courts, and by the United States Circuit Court, has been that manufacturers are liable for injuries that can be traced to defective materials only when the articles involved are "inherently dangerous," such as fire-arms. The New York court has now sharply departed from this rule, upholding a decision in a lower court which, it had been confidently predicted, would be reversed under the long-standing precedents above referred to. As the case is of considerable interest to all manufacturers of heavy equipment used in contracting and as it defines anew the rights of those who may suffer from defects in such equipment, the main features of the case are well worth noting.

The facts are that the purchaser of a motor car was seriously injured as the result of the collapse of one of the wheels of the car after it had been in use for a year. The manufacturer resisted a suit for damages on the ground that he was not the maker of the wheels, but had bought them from a responsible manufacturer and used ordinary caution to ascertain that they were sound. It was shown that the collapse of the wheel was due to defective wood. The Court of Appeals now holds that the manufacturer "was responsible for the finished product," and cannot shift the responsibility. The decision places squarely upon every manufacturer of a "finished product" —a hoist, for example—full responsibility for injuries that may result from defects in any part of such a product. The court specifically says that a manufacturer is not at liberty to put the finished product on the market without making such tests as will prove the absence or presence of such defects as might result in injuries through ordinary use.

It is clear that we have here a new rule of law, and one that may make serious trouble for a manufacturer who proceeds upon the old theory that he is not responsible for injuries resulting from defective parts of assembled machines or equipment. If further light on this interesting case is desired it may be found in the decision handed down by Judge Cardozo March 14, in the case of Donald C. MacPherson vs. the Buick Motor Company.

Mechanical Filters Recommended for City with Slow-Sand Plant

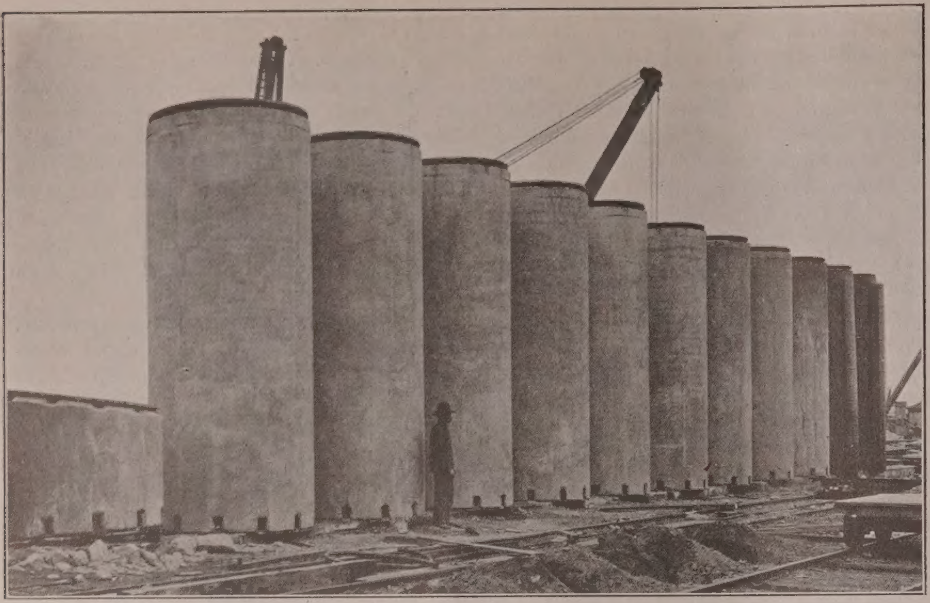
IN George W. Fuller's recent report advocating a $750,000 addition to the water-supply and purification works at Wilmington, Del., one of the most interesting features is the recommendation of mechanical filters in a city now equipped with a slow-sand plant and pre-filters. The principal reason for the suggested change appears to be the unexpectedly large amount of finely divided clay which, at times, is carried by Brandywine Creek, the source of supply. When the type of filter now built at Wilmington was considered a dozen years ago, the operating difficulties of slow-sand plants in the treatment of water highly charged with fine clay particles was not fully realized, nor was it appreciated how efficient and reliable were rapid-sand filters, such as have been installed since that time at Baltimore, Harrisburg, Columbus, Cincinnati, Louisville, Minneapolis, St. Louis and New Orleans. On the whole, Mr. Fuller finds, the existing Wilmington filters have made a surprisingly good record in the removal of clay, and this is explained largely by the amount of fine material which seems to have accumulated in the lower portion of the sand layers, below the depth efficiently reached by the teeth of the Blaisdell washing machine. Nevertheless, the accumulations of clay and other matter in the lower portions of the beds have now reached such proportions that the filters are seriously clogged and need a thorough washing and overhauling.

While the conditions described are potent arguments for coagulation and rapid filtration, they are not the only ones. Structural defects in the existing filters have made it practically impossible, at certain seasons, to realize from the works their rated output, Shrinkage cracks in the filter floors have given rise to many troubles. Clogging and air-binding have caused the most serious annoyance—conditions which were described fully by Edgar M. Hoopes in the Engineering Record, Sept. 4, 1915, page 282.

The Wilmington case will appeal to sanitary engineers because the decision as to plant enlargement, along lines radically different from the original designs, is based, not on surmise, but on actual operating results over a long term of years. This is the best kind of evidence upon which to base a decision. It should be realized, however, that progress, during recent years, in the development of the mechanical filter to its present high state of efficiency has introduced into the solution of the water-purification problem a factor which was not present before. Events at Wilmington are not the only ones which substantiate this view. In the case of the Torresdale filters at Philadelphia the same trend is manifest, for the city long ago supplemented its slow-sand filters with pre-filters, operating at high rates, and is now completing the construction of a large coagulating basin as a further measure to free the raw water of its burden of suspended matter. Thus, while the Philadelphia units are nominally of the slow-sand type, their accessory equipment carries with it decided suggestion of mechanical-filtration principles. The same tendency is being exhibited at Wilmington in a stronger degree, for in addition to his recommendation for a mechanical-filtration plant, Mr. Fuller suggests that coagulation facilities be provided as a preliminary to treatment at the existing slow-sand beds.

It is not proposed at Wilmington to have the mechanical filters supersede the existing slow-sand plant. They will serve as an additional means of increasing the output of purified water. They will, however, play another part of very timely importance. Unless they are built it will be practically impossible to shut down the present works for the repairs which are needed.

Since the war started Wilmington has assumed a position of tremendous industrial importance because of its huge output of power and explosives. The population curve has risen rapidly, and the need for an adequate water supply for present and future is more acute now than ever before.



OUTFALL PIPE CONSISTS OF 18-FOOT SECTIONS OF CONCRETE 6 FEET IN DIAMETER

Cleveland's Sewage Treated by Revolving Screens and Novel Grit Chambers

Ejectors Will Remove Grit for Filling Purposes—Long Submerged Outfall Will Disperse Sewage in Region of Cross Currents

By GEORGE B. GASCOIGNE
Principal Assistant Engineer, Subdivision of Sewage Disposal, City of Cleveland

THE sewage from that part of Cleveland west of the Cuyahoga River will be treated at a plant located on the lake front at the foot of West Fifty-eighth Street. It is intended to use the dilution available opposite this lake-front plant, so that ultimately the works will provide for the removal of the suspended inorganic matter; the partial clarification of the sewage; the discharge of the excess storm flow at the U. S. harbor line; the dispersion in the lake of the treated effluent, and disinfection during the bathing season.

GRIT CHAMBERS AND FINE SCREENS

In order to determine the possibility of an initial cost saving by using, for the clarification of the sewage, fine screens instead of two-story setting tanks and to protect the public bathing beach located nearby, construction of a partial plant, capable of treating the flow already discharged at this location was started. When the remainder of the sewage reaches this location it is expected to have the complete plant ready for operation, provided the fine screens produce the results which are claimed by their designers. Otherwise, the sewage will be discharged temporarily through the submerged outfall pipe without the degree of clarification necessary.

Two grit chambers of different types, with their flow channel connections and the screen house, are completed and 14-ft. circular Reinsch-Wurl screens are provided for continuous operation. Sewage passed through the grit chambers and screen for the first time Nov. 19, 1915. The outfall sewer and the submerged outfall pipe are in the course of construction.

COLLECTION AND FLOW

The population ultimately served at this location will represent 28 per cent of the city's total. Two interceptors collect the sewage and with the necessary overflows and by-passes discharge it at the plant. The westerly interceptor, which is of the combined type, serves largely a residential district and extends westward along the lake shore about 3 miles. The sewage as discharged is fresh and in amount equals about one-fourth of the total quantity to be treated. The normal flow per capita is 150 gal. per 24 hr., with an hourly fluctuation of 25 per cent. The Walworth Run sewer, which serves the territory back from the lake front, at the present time discharges into the Cuyahoga River about 2 miles upstream from its mouth. In order to divert the sanitary flow and the first storm wash of this sewer to the treatment site, a 5½-ft. circular brick sewer with an outside lining of wood cants is being constructed.

The Walworth Run diversion sewer, so-called, is in tunnel, 80 ft. below the surface of the ground and 8350 ft. in length. This sewer will deliver the remaining three-fourths of the total quantity to be treated. The normal flow per capita amounts to 75 gal. per 24 hr., with a maximum and minimum hourly fluctuation of 22 and 32 per cent, respectively. The main portion of the stock yard wastes of the city enter this sewer, which condition affects the character of the sewage.

The estimated population contributing sewage to the West Fifty-eighth Street plant will, in 1925, be 275,000. The works planned for construction will provide for this population and will treat twice the sanitary flow of the westerly interceptor and four times the dry weather sewage flow of the Walworth Run sewer, which is equivalent to 300 gal. per capita per 24 hr. The entire flow will first pass through the coarse screens and grit chambers and then 75 per cent of this amount will be either settled or screened, the difference being by-passed to the outfall sewer. The final step in the treatment process consists in dispersing the settled or screened effluent in the lake by means of an outfall tube.

COARSE SCREENS

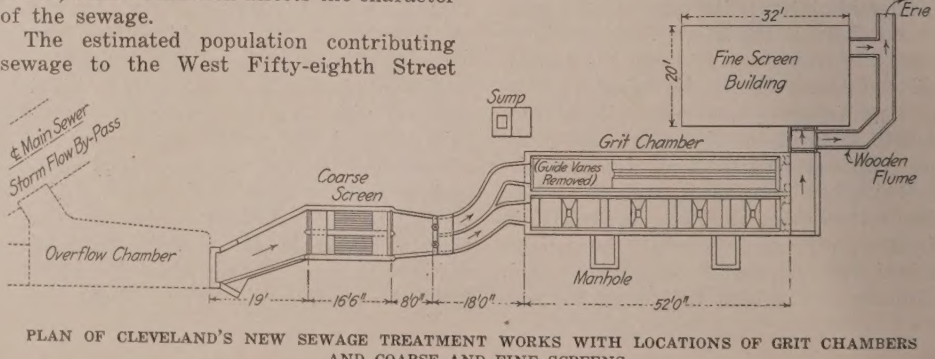
For the purpose of preventing large objects, such as boards, bundles of wire and tin buckets from reaching the fine screen and from interfering with the operation of the valves and stop planks of the plant, two coarse screens, 4 ft. wide, are located in the flow channels at the entrance to the grit chambers. They consist of ½ x 2-in. steel bars spaced on 3½-in. centers and have a platform at their top for the attendant to stand upon when raking off the screenings. The bars are separated by means of castings, so shaped that a rake may be drawn throughout the entire length of the screens. The screens, as at present installed, are placed at an angle of 30 deg. with the horizontal, and slots are available for changing this angle to 45 deg. The necessary stop plank grooves and boards are provided so that either screen may be entirely shut off from the flow.

GRIT CHAMBERS

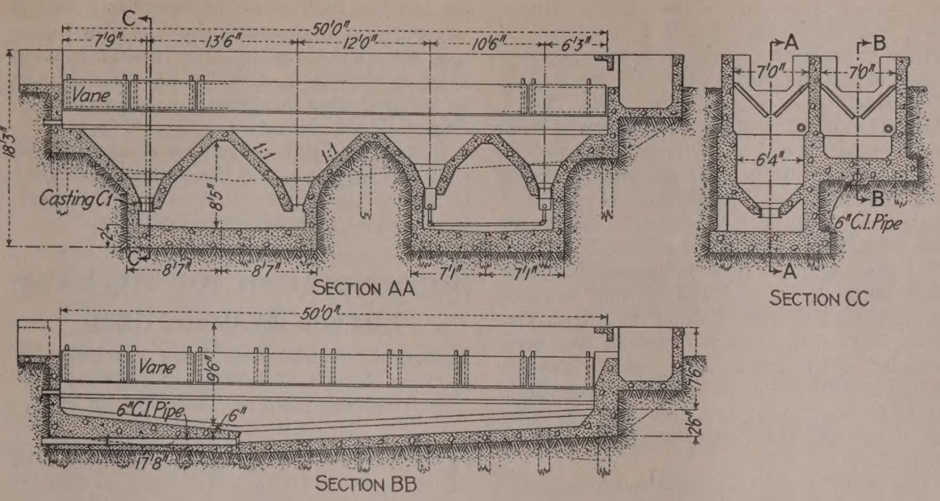
The grit chambers, as constructed, are sufficient to treat a quantity equal to twice the sanitary flow from the westerly interceptor, and when the flow from the Walworth Run sewer enters the plant, four additional chambers will be necessary. The present two are so located that with the additional four the symmetry of the works will be carried out.

In the design of the grit chambers the importance of securing a grit which can be satisfactorily used for filling purposes is paramount. Data obtained during the operation of the testing station show that grit which contains on the average more than 15 per cent of volatile matter will produce, when handled during unfavorable weather, objectionable conditions. It was thought advisable to increase slightly the cost of the grit chambers in order to secure this uniform quality of grit.

The flow section is designed to give a velocity of 1 ft. per second when the quantity passing through a chamber varies from 8,000,000 to 16,000,000 gal. per day. Each chamber is divided into two compartments,



PLAN OF CLEVELAND'S NEW SEWAGE TREATMENT WORKS WITH LOCATIONS OF GRIT CHAMBERS AND COARSE AND FINE SCREENS



GRIT CHAMBERS HAVE BOTTOMS OF TWO TYPES—WITH HOPPER BOTTOM EJECTORS REMOVE GRIT WITHOUT STOPPING FLOW BUT WITH FLAT BOTTOM TANK MUST BE SHUT DOWN FOR CLEANING

an upper or flow section, and a lower or deposition section. The flow section is made by attaching to the vertical side walls of the chamber steel plates or vanes and hanging them so that they converge to a 6-in. slot. The flow line, when sewage is passing through the grit chambers at a rate of 8,000,000 gal. per day, will coincide with a line which represents the intersection of the vertical walls and the upper surface of the steel plates or guide vanes. This construction eliminates the uncertain and variable flow section usual in grit chambers of the open type and gives a fixed and uniform section throughout the entire length of the chamber. Flows between 8,000,000 and 16,000,000 gal. are controlled by means of a modified outlet weir, so that the velocity remains constant. The weir is of the rectangular type, the central portion of which is contracted to a low head orifice.

The chambers are 50 ft. long, which permits a detention period of 50 sec. and provides for a deposit of ½ cu. yd. of grit per 1,000,000 gal. of flow. The storage capacity has been made of such size that the normal operating force can remove the grit from a chamber without seriously interfering with other necessary work around the works. If the sewage should at times contain no grit, and objectionable material is being deposited, it will be possible to by-pass the chamber sufficiently by closing the slot at the bottom of the guide vanes.

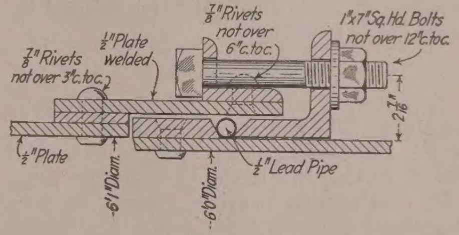
It was found from the tests with open chambers that grit will not deposit uniformly throughout the entire length of the chamber and it is believed the 6-in. slot will, to a certain extent, favorably affect the distribution. Each chamber is so constructed that 60 per cent of the total storage volume occurs in the first or inlet half, irrespective of whether or not the bottom is flat or hoppered.

In order to permit any material which rises behind the vanes to be carried away, a horizontal opening about 6 in. wide was provided in the guide vanes at their top and next to the vertical walls. There will be cross currents through the deposition chamber, but the effect from any objectionable material so deposited, and which does not get away, will be compensated for by the large quantity of good grit.

CAST-IRON Y WHICH REDUCES FROM 6 TO 5-FOOT DIAMETER SECTION OF CONCRETE PIPE

It will be noticed from the drawings that the bottoms of the two chambers differ. This is due to the method of cleaning the chambers, it being necessary in the one with the flat bottom to shut off the flow when removing the grit, while in the one with the hoppered bottom it is hoped to remove the grit without stopping the sewage flow. Sand ejectors are fastened to the bottom of the four hoppers which form the floor for one chamber and they will be operated by the city water pressure. The material so ejected will be used for filling purposes around the works, and a sand discharge line has been provided which is sufficient to carry the grit a distance of 400 ft. The grit in the chamber with the flat bottom will be removed by means of a sand ejector of the portable type, which has been provided. The possibility of operating the sand ejectors unsuccessfully is emphasized by the fact that two types of chambers were constructed.

Within the working galleries, which are located beneath the first and second hopper and the third and fourth hopper, respectively, of the grit chambers, there is placed the necessary piping and valves for controlling the operation of the sand ejectors. In the completed plant these galleries may extend across the six grit chambers, with the necessary entrance steps.


7/8" Rivets not over 6" c. to c.
1"x7" Sq. Hd. Bolts not over 12" c. to c.
1/2" Plate welded
7/8" Rivets not over 3" c. to c.
2 7/8"
1/2" Plate
6'1" Diam.
6'0" Diam.
1/2" Lead Pipe

DIVER JOINS SECTIONS OF OUTFALL SEWER BY SUBMARINE JOINT

In order to remove the supernatant liquid and that which drains through the grit, a centrifugal pump and motor have been installed within a sump well off to the side of the inlet end of the grit chambers. The liquid so discharged will be delivered into the flow channel just back of the coarse screens.

FINE SCREENS

In order partially to clarify the sewage, a screen of the Reinsch-Wurl type has been installed in a pit within a frame building located at the outlet end of the grit chambers. The screen consists of a 14-ft. circular disk of brass with the central portion removed and a truncated cone with vertical plates inserted. In the center of the cone and plate is a shaft inclined 10 deg. to the vertical, around which the screen revolves. The shaft is supported by bearings entirely above the sewage flow, a feature which distinguishes the screen as the overhung type. The plate is perforated with openings 1/32 in. wide and 2 in. long, which represents about 10 per cent of the total screen area given over to openings. The screen rests in the pit partly submerged, and as it revolves the floating solids are carried along its surface until they are swept off by revolving brushes. These brushes are of wild hogs' bristles and at the end of arms which extend from the second central rotating shaft. A 2½-hp. motor, especially fitted, is placed on a walking bridge above the screen and provides power for revolving the disk and brushes.

The screen is rated at a capacity of 7,500,000 gal. per 24 hr., with a loss of head equal to 2 ft. This quantity is equivalent to approximately the normal dry-weather flow of the westerly interceptor. The flow line, when this maximum condition occurs, is flush with the top of the truncated cone on the inlet side. If the removal results are in excess of those expected, it will be possible to increase the capacity of the screen by enlarging the openings.

The screen was installed on trial, and the designers guarantee that the results obtained from its operation will compare favorably with those obtained from a settling tank which has a flowing-through period of 1½ hr. A tank will be constructed and operated alongside the screen in order to secure comparative results. A small room has been partitioned off in one corner of the building, which will serve as an office and laboratory. An employee of the city will make the analytical determinations and keep the operation data which pertain to the efficiency of the screen.

At the present time it is proposed to collect the screenings in burlap bags, reduce their moisture content by centrifuging and then burn the residue in a small incinerating plant located in the building. The screen was manufactured by the Sanitation Corporation of New York City and shipped in boxes ready to set up.

OUTFALL SEWER

In order to eliminate any objectionable conditions which occur opposite the sewer outlet, the present sewer will be extended 600 ft. farther out to the U. S. harbor line. This construction provides means for discharging the excess storm flow—the sewage flow which will not pass through the treatment works—in 25 ft. of water. This outfall sewer is of reinforced concrete, an open channel 4½ ft. deep, 15 ft. wide, supported on piling and has its invert paved with brick. The pile bents are on 6-ft. centers and consist of four piles each, which vary in length from 25 to 65 ft.

SUBMERGED OUTFALL PIPE

The effluent from the treatment works will be discharged outside the Cleveland breakwater through a submerged outfall pipe, where it is estimated the dilution amounts to 2 cu. ft. per 1000 population contributing. The location selected for dispersing the sewage is just off the junction of the main arm and the westerly wing of the breakwater, about 3700 ft. from shore, and where pronounced cross-current conditions prevail.

A concrete head chamber, which provides an entrance to the outfall pipe, is located off to the side of the outfall sewer about 400 ft. in from the harbor line. The outfall pipe from this chamber to the harbor line is of reinforced concrete and 6 ft. in diameter, and placed beneath the outfall sewer on timber supports, which are fastened to the two inside piles of the bents. The pipe was made at the contractors' yard near the site of the work and poured vertically in 18-ft. sections with cast-iron flanges on each end. These sections are placed by a derrick scow and bolted together by a diver.

At the harbor line and on the end of the concrete pipe there has been placed a cast-iron Y which reduces from the 6-ft. to the 5-ft. section. Conditions for the year 1925 require only one discharge line, but eventually two 60-in. lines will be necessary from this point. One side of the Y has, therefore, been bulkheaded and left ready for the future connection. Laid in a trench excavated along the lake bottom, a 60-in. riveted steel pipe extends out from the Y connection or harbor line a distance of 2600 ft. to where there is a 30-ft. depth of water.

For dispersing the effluent, a tapered section of pipe, 1000 ft. long, and having 6¾-in. circular openings spaced on 7½-ft. centers, is attached to the end of the 60-in. line. This discharge section varies in diameter from 60 to 24 in. and will be held in place by anchor piling placed along its sides. The outlet end of the tapered section has been provided with a flap gate which can be weighted so that the openings will take their intended portion of the flow and the pipe line under abnormal flow conditions will be flushed out.

The steel pipe is coated with mineral rubber asphalt and is shipped from the manufacturer in 30-ft. lengths. Five of these lengths, after being riveted together on the shore into a 150-ft. section, are lowered into place by two dredges with their cables attached around the pipe at the outer quarter points. The section fills with water as soon as it is submerged and a diver joins the sections by means of the submarine joint illustrated. The work is being performed by the Great Lakes Dredge & Dock Company.

DISINFECTION

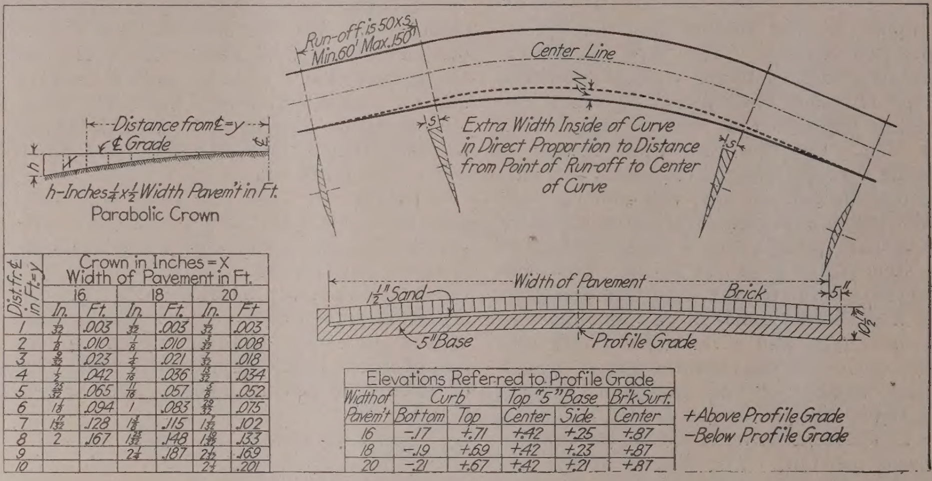
In order to disinfect the sewage this summer, apparatus of a temporary nature will be installed over the head chamber. At the present war quotations, data obtained during the operation of the testing station tend to show that sodium hypochlorite can be applied cheaper than calcium hypochlorite or liquid chlorine.

Robert Hoffman is chief engineer for the City of Cleveland, and the sewerage project is under the supervision of R. Winthrop Pratt, consulting sanitary engineer.

Superelevation for Highway Curves Systematized

Tables and Formulas for Brick Pavements of King County, Washington, Take Into Account Motorists' Tendency to Cut Corners

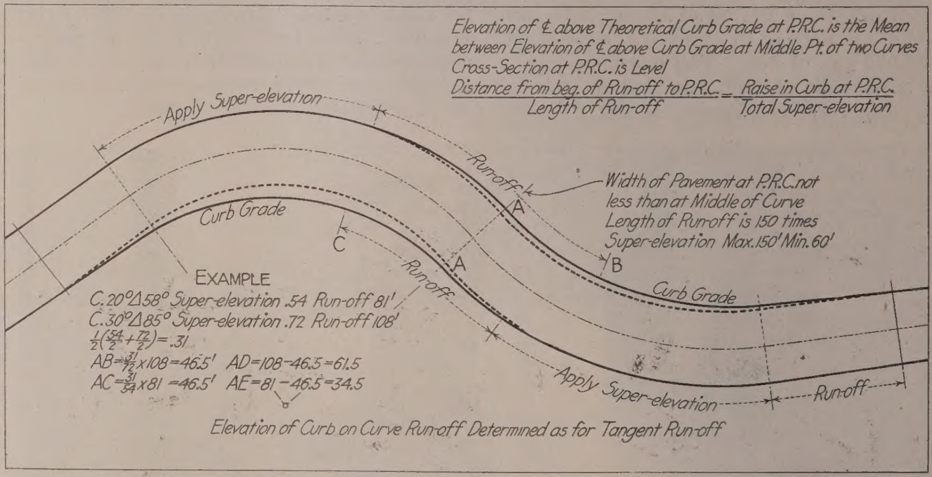
THE large amount of brick pavement laid in recent years in the vicinity of Seattle and in King County generally has brought out the need for some uniform system of superelevation and easy approach thereto which would be suitable for the wide variety of vehicles that use the so-called "permanent highways" of that section. In attempting to develop a standard of superelevation the difficulty encountered by the engineer in charge of this work was that curves of the same degree do not always require the same amount of superelevation.



Dist. fr. ℄ in Ft. = y	Crown in Inches = X Width of Pavement in Ft.					
	16		18		20	
	In.	Ft.	In.	Ft.	In.	Ft
1	1/32	.003	1/32	.003	1/32	.003
2	1/8	.010	1/8	.010	3/32	.008
3	9/32	.023	1/4	.021	7/32	.018
4	1/2	.042	7/16	.036	13/32	.034
5	25/32	.065	11/16	.057	5/8	.052
6	1 1/8	.094	1	.083	29/32	.075
7	1 17/32	.128	1 3/8	.115	1 7/32	.102
8	2	.167	1 25/32	.148	1 19/32	.133
9			2 1/4	.187	2 1/32	.169
10					2 1/2	.201

Elevations Referred to Profile Grade					
Width of Pavem't	Curb		Top "5" Base		Br'k Surf.
	Bottom	Top	Center	Side	Center
16	−.17	+.71	+.42	+.25	+.87
18	−.19	+.69	+.42	+.23	+.87
20	−.21	+.67	+.42	+.21	+.87

CROWN AND CURVE CONSTRUCTION WITH TABLES


Elevation of ℄ above Theoretical Curb Grade at P.R.C. is the Mean between Elevation of ℄ above Curb Grade at Middle Pt. of two Curves
Cross-Section at P.R.C. is Level
Distance from beg. of Run-off to P.R.C. / Length of Run-off = Raise in Curb at P.R.C. / Total Super-elevation
Apply Super-elevation
Run-off
Width of Pavement at P.R.C. not less than at Middle of Curve
Length of Run-off is 150 times Super-elevation Max. 150' Min. 60'
A
B
Curb Grade
C
A
Run-off
Curb Grade
EXAMPLE
C. 20° Δ 58° Super-elevation .54 Run-off 81'
C. 30° Δ 85° Super-elevation .72 Run-off 108'
½(54/2 + 72/2) = .31
AB = 31/72 x 108 = 46.5' AD = 108 − 46.5 = 61.5
AC = 31/54 x 81 = 46.5' AE = 81 − 46.5 = 34.5
Apply Super-elevation
Run-off
Elevation of Curb on Curve Run-off Determined as for Tangent Run-off

LAYOUT OF SUPERELEVATION AND RUN OFF ON REVERSE CURVES

For example, it was noted that 20-deg. curves with a 20-deg. central angle should be given much less superelevation than curves of the same degree with 90 or 100-deg. central angles. The reason for this is that the greater the degree of curvature, the more nearly the vehicle traversing the road will follow the theoretical alignment. On any curve whose central angle is comparatively small, motor traffic in particular will cut across, actually following a curve whose degree of curvature is much less than that of the actual curve of the roadway.

OLD TABLES REVISED

Tables for superelevation prepared by the Washington State Highway Department a few years ago were at first used on the King County work. These tables, however, provided for a pavement cross-section which continued throughout the length of the curve and had a warped run-off on either side of point of curve and point of tangent equal to one-sixth of the length of the curve and limited to a minimum of 40 ft. This method of determining superelevation was satisfactory under certain conditions, but was not found generally applicable.

Tables were therefore prepared for King County work which provided for a minimum superelevation equal to double the crown of the pavement and made the surface plane instead of warped. In computing the tables the idea has been to suit the superelevation as nearly as possible to the actual line of travel which the motor traffic will naturally follow. The table for an 18-ft. roadway is reproduced herewith. The values are not all deducted mathematically, but were determined in part after study and observation of conditions on pavements in service. These tables have been used for the construction of 16, 18 and 20-ft. pavements and are said to be very satisfactory in that they not only give the road a good appearance but afford safe, easy-riding curves.

The tables were devised by Arthur P. Denton, county engineer, King County, Washington.

TABLE OF SUPERELEVATION IN FEET FOR 18-FT. PAVED HIGHWAY

Deg. of curve	Central Angle 12	16	20	24	30	36	42	48	54	60	64	70	80	90	100	110	120	130	140	150	160	Deg. of curve
3	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	3
4	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.39	.39	.39	.39	.39	.39	.39	.39	.40	.40	.40	4
5	.38	.38	.38	.38	.39	.39	.39	.39	.39	.39	.40	.40	.40	.41	.41	.41	.41	.41	.42	.42	.43	5
6	.38	.39	.39	.39	.39	.39	.39	.40	.40	.40	.40	.41	.41	.42	.42	.43	.43	.44	.44	.44	.45	6
7	.38	.39	.39	.39	.39	.40	.40	.40	.41	.41	.41	.42	.42	.43	.43	.44	.45	.47	.47	.47	.48	7
8	.38	.39	.39	.40	.40	.40	.40	.41	.41	.42	.42	.43	.43	.44	.45	.46	.47	.49	.50	.50	.51	8
9	.38	.39	.39	.40	.40	.41	.41	.41	.42	.43	.43	.44	.45	.45	.47	.48	.49	.50	.52	.53	.53	9
10	.38	.38	.39	.40	.40	.41	.41	.42	.42	.43	.43	.44	.46	.47	.49	.50	.51	.52	.54	.55	.56	10
12	.38	.38	.39	.40	.41	.41	.42	.43	.43	.44	.45	.45	.47	.49	.51	.52	.53	.54	.56	.57	.58	12
14	...	.38	.39	.40	.41	.41	.42	.43	.44	.46	.46	.47	.49	.51	.53	.54	.56	.57	.59	.61	.63	14
16	...	.38	.38	.40	.41	.42	.43	.44	.45	.47	.48	.49	.51	.53	.55	.57	.59	.61	.63	.65	.66	16
18	...	...	.38	.39	.41	.42	.44	.45	.46	.48	.49	.50	.53	.55	.58	.60	.63	.65	.68	.70	.73	18
20	...	...	.38	.39	.41	.43	.44	.46	.47	.48	.49	.50	.53	.56	.59	.62	.65	.68	.72	.75	.78	20
22	...	...	.38	.39	.41	.43	.44	.47	.49	.50	.51	.52	.56	.60	.62	.66	.69	.72	.76	.80	.83	22
24	...	...	...	.38	.41	.43	.45	.48	.51	.52	.53	.54	.59	.63	.66	.70	.73	.77	.80	.84	.88	24
26	...	...	...	.38	.40	.43	.45	.48	.50	.52	.55	.57	.61	.65	.70	.73	.77	.82	.86	.90	.94	26
28	...	...	...	...	.38	.42	.44	.48	.50	.53	.55	.57	.62	.66	.71	.76	.80	.84	.89	.94	.99	28
30	...	...	...	...	.38	.40	.44	.47	.50	.53	.55	.57	.63	.68	.73	.77	.83	.88	.93	.99	1.04	30
32	...	...	...	...	...	.38	.43	.46	.49	.54	.55	.58	.64	.70	.75	.81	.87	.93	.98	1.04	1.09	32
36	...	...	...	...	...	.38	.42	.46	.49	.54	.55	.60	.67	.74	.80	.87	.93	1.00	1.06	1.13	1.19	36
40	...	...	...	...	...	...	.38	.44	.49	.54	.57	.60	.66	.75	.82	.90	.99	1.06	1.14	1.22	1.29	40
44	...	...	...	...	...	...	.38	.43	.49	.54	.57	.62	.70	.79	.87	.96	1.05	1.13	1.22	1.30	1.39	44
48	...	...	...	...	...	...	...	.38	.44	.50	.54	.60	.70	.80	.90	.99	1.09	1.19	1.30	1.40	1.50	48
54	...	...	...	...	...	...	...	...	.38	.45	.50	.58	.70	.82	.94	1.06	1.18	1.30	1.43	1.54	1.66	54
60	...	...	...	...	...	...	...	...	...	.38	.43	.52	.67	.81	.96	1.10	1.25	1.39	1.54	1.68	1.82	60

Venturi Meter Developed for Accurate Measurement of Irrigation Water

Effort Made to Inaugurate Equitable Basis for Charges to Water Users on Western Projects by Abolishing "Flat Rate" System

By ALAN A. WOOD
Western Representative, Builders' Iron Foundry, Providence, R. I.

TO place charges for irrigation water upon a more equitable basis than is possible under a system of "flat rates," which has resulted in endless disputes and litigation, the Venturi meter principle of accurate flow measurement has been adapted to the special conditions existing on some of the Western reclamation projects. As a result of studies in California, Arizona, Washington and Oregon a special type of recording Venturi equipment has been developed to take the place of such form of measuring devices as measuring boxes, weirs, submerged orifices, and current meters. The first installation of the new apparatus was made on the U. S. Reclamation Service's Salt River project in Arizona in 1913. Since that date the recording meters have been used in a number of other localities. The design of the Venturi tube is entirely special, being bent to form an inverted siphon. The pressure chambers have been omitted and a departure has been made from the standard dimensions and curves. All of these changes necessitated exhaustive calibration of the first designs.

RECORDING APPARATUS OF VENTURI METER IN COMPACT CASE

FLAT RATES CAUSED DISPUTES

There have been many instances of friction leading to lawsuits between vendors and purchasers of irrigation water arising from the impossibility of determining with any reasonable degree of certainty whether or not the charge for water was equitable—that is, in proportion to the amount actually delivered to the user. There have been instances in which it has been affirmed by water users that irrigation water paid for by them has been diverted by company officials for their own profit or by other unauthorized persons. In other cases users charge that the water for which they are paying is largely dissipated and lost in passage through unlined canals and ditches.

Those interested primarily in supplying, rather than actually using, irrigation water, frequently complain that over-irrigation is being practised by the farmer. Lands for which from 4 to 5-in. irrigation is most efficient are irrigated from 15 to 25 in., and irrigations as high as 45 in. per season have been known. Not only is this excessive use of water injurious to the farmer's own crops but failure to drain properly permits the run-off to ruin lower lands by bringing the alkali to the surface. Within the past ten or fifteen years the conviction has gradually been growing that accurate measurement of water delivered is the only solution to these difficulties.

IRRIGATION METER REQUIREMENTS

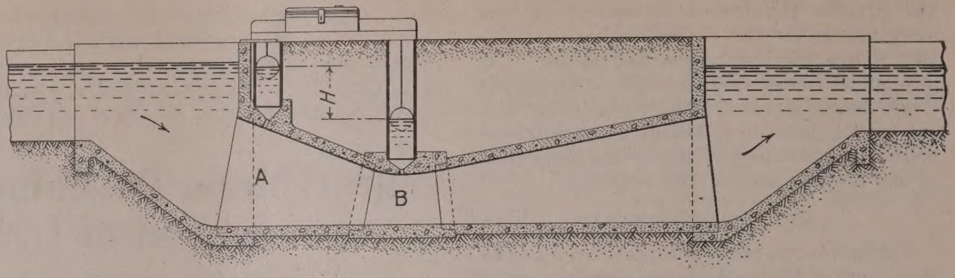
To be suitable for general adoption an irrigation meter must be reasonable in cost; must read directly in recognized units, such as acre-feet or second-feet, without the necessity of calculation; must introduce very little loss of head; must give the same discharge wherever placed; must be "tamper-proof;" must not be easily clogged by silt deposits, sticks, or debris; and must have a discharge which is not affected by variations of water level in the supplying canal. Another feature which is desirable, although not absolutely essential, is the ability to regulate and keep constant the flow through the ditches, either automatically or through the information furnished by the meter.

The weir method of measurement has been adopted to some extent on irrigation projects, but its general use is hindered by the fact that it implies a loss of head equal to approximately the depth of water flowing over the weir. In practice very few weirs are found which are designed with the observance of the generally recognized specifications for standard weirs; fewer still are kept in proper repair after installation. The channel is frequently found obstructed by silt, the bottom is built up and the end contractions partly suppressed. It is usually impracticable, except in the case of very large companies and water users' associations, to employ a competent engineer to construct correctly weirs and maintain them in proper order. Without expert supervision the results with weirs are often unsatisfactory.

Measuring boxes are in quite satisfactory use in some localities, but are generally employed to proportion the quantity supplied each user, rather than serve as a means of measurement.

Mechanical meters of the moving-vane or paddle-wheel type are used quite extensively. The axis of rotation of the wheel is either horizontal or vertical. The meter registers the flow without indicating or recording it upon a chart. In many cases the revolution of the wheel can be stopped without stopping the passage of water and the meters are somewhat subject to clogging by sticks, brush, tumble-weed, silt, etc.

It has been suggested many times that the solution of the problem of irrigation measurement would ultimately be found in the use of a device upon the principle of the Venturi meter, invented in 1887 by Clemens Herschel. Although Venturi meters have been employed to meet a great variety of conditions in municipal gravity and pumping plants, hydraulic power installations and filter plants, irrigation engineers have felt that for their work the cost of the standard Venturi meter tubes and instruments, which in the case of the usual installation is very small compared with the total cost of the work, would be prohibitive in irrigation projects. It was recognized, however, that the Venturi meter tube, which contains no mechanism, presents some peculiar advantages for irrigation measurement, among which are wide measuring range, small loss of head, and freedom from clogging.



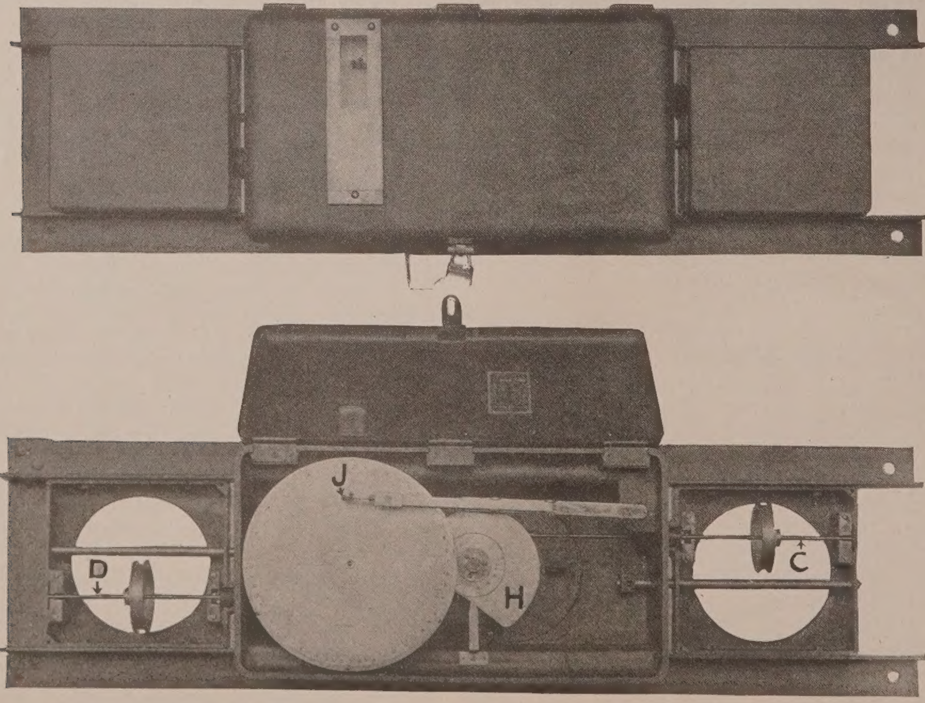
RELATION OF PARTS OF VENTURI IRRIGATION METER

As early as 1908, F. N. Connet, M. Am. Soc. M. E., chief engineer of the Builders' Iron Foundry, of Providence, R. I., perfected the design of a Venturi meter especially adapted for irrigation work. About five years intervened during which studies of conditions in California, Arizona, Oregon and Washington were made. Finally in 1913 the first installation under service conditions was made on the U. S. Reclamation Service, Salt River project, near Phoenix, Arizona.

VENTURI PRINCIPLES

The fundamental Venturi formula $V = c\sqrt{2gH}$ still obtains. V is the velocity through the throat in feet per second; c a constant, depending upon the design of the meter; g the acceleration due to gravity; and H the acting head or difference in pressure at the inlet and throat of the meter tube. The head at the inlet A in the drawing is practically the level of the canal, lateral or ditch in which the tube is placed. The head at throat B is the head at A minus the differential head, H. This difference in head is converted into velocity and is not lost in eddies or friction. The function of the outlet or downstream cone is to reduce the throat velocity gradually to that in the ditch and thereby recover the pressure temporarily lost at the throat.

In the standard Venturi meter instruments the pressures at A and B operate mercury columns when the meters are subject to heavy pressures as in hydraulic power plants. Under low head conditions, as in filter plants, the water columns in the tubes connected to the inlet and throat are used to operate floats which, in turn, actuate the instrument by cables. Several hundred installations of this type are in service.



METER CASE CLOSED (TOP) AND OPEN (BOTTOM) SHOWING ARRANGEMENT OF MECHANISM

The same principle is used in the Venturi irrigation meter instrument. Two floats operate in pipes connected to the inlet and throat of the meter tube and rest upon the surface of the water levels within those pipes. By the use of cables properly counterweighted these floats operate the shafts C and D, shown in the photograph, and these in turn, through differential and bevel gears, control the movement of the cam H. The cam moves a roller and arm which carries the pencil J. The purpose of the cam is to get from the square root of the head H to the discharge Q which is a quantity of the first power. The calibration curve of the meter is, therefore, nearly a straight line over the entire range of operation. Care was taken to eliminate friction so far as possible, and at the same time to construct the instrument with sufficient ruggedness and simplicity to enable it to withstand the severe conditions of irrigation service.

The photographs illustrate particularly the cam, the pencil arm and the chart. The latter is circular and is usually graduated for seven days. The window in the case permits observation of the chart without the necessity of swinging back the cover. The latter is hinged and fastened with a small padlock; a sliding shutter protects the glass from possible injury. When it is desired to remove the chart, the cover of the meter is lifted, the pencil slipped up, and the chart replaced.

The chart record method of measurement is advantageous in many ways. The records usually approximate a perfect circle or a portion of one and the totals can frequently be determined by observation.

Where it is desired, a chart planimeter may be used for integrating the records. Should any unusual condition obtain, such as an attempt at tampering, an indelible trace is left for the ditch rider to observe. The time of turning water on and off, the amount delivered to any particular tract, the efficiency of the irrigators may be determined from the record. The charts, therefore, form a basis for the study of water waste and an aid to systematic conservation of the supply. The advantage of the permanent record as an aid to settling disputes between vendor and purchaser is beyond question.

COMPARATIVE TESTS

Some of the first tests were made by the engineers of the U. S. Reclamation Service on the Salt River project. Since means for volumetric measurement were not available, comparison was made between the Venturi, a recently calibrated current meter, and a rectangular weir. Care was taken to obtain weir conditions as nearly ideal as possible.

The following paragraph is an extract from the report by the Board of Engineers appointed by the project manager of the Salt River Project, at the request of the board of governors of the Salt River Valley Water Users' Association.

"The test for accuracy was made on a standard 15 sec.-ft. capacity Venturi meter. All discharge measurements were made by Frank Asplind with a regulation Price acoustic meter and were checked by observation of flow through a standard rectangular weir, corrected for velocity of approach. The discharge of the Venturi meter was measured at twelve separate points, ranging from 2.96 cu. ft. per second to 16.86 cu. ft. per second, the loss of head being measured in each case. If the weir readings be accepted as standard, the Venturi meter reads 1.67 per cent low, and if the current meter readings be accepted as standard the Venturi meter reads 2.72 per cent high. Thus it will be seen that there is a greater discrepancy between the readings from the two methods used to check the Venturi meter than there is between the readings of either compared with the readings of the Venturi meter."

This may be at least partially accounted for by the fact that because the Venturi principle takes into account differences in pressure, velocity of approach, nearly always an uncertain quantity is eliminated and the coefficients of discharge are nearly constant over the entire measuring range.

The report goes on to say that both clear and muddy water as well as trash were passed through the meter tube without derangement. It was found that the meter is adapted for use in numerous cases, especially at the heads of the main laterals and on the farm turnouts.

The loss of head occasioned by the insertion of the meter tube in the ditch is under usual conditions less than 2 in.

MATERIALS FOR METER CONSTRUCTION

Various materials have been used for Venturi meter tubes, the type of construction depending upon the locality. Cast iron is, of course, desirable but the comparatively high cost of this material in isolated localities limits its use. An excellent design is the use of a cast-iron throat with ingot iron cones. In a great number of instances the use of concrete throughout is recommended and after the forms are obtained the cost is nominal. The writer does not recall any instances of Venturi irrigation meter tubes constructed of wood staves, but there is reason to believe that this design would be found suited to many localities.

In addition to the installation previously mentioned, the Venturi meters have been placed on the Yuma and Sunnyside (North Yokima) projects of the U. S. Reclamation Service; on the systems of the California Development Company at Calexico; on the property of Imperial Water Company, in the Imperial Valley, California; and for experimental purposes by Leland Stanford University at Palo Alto, and the University of California experimental farm at Davis. In some instances a gate is placed immediately following the meter and the proper amount of water to be applied can be governed to a nicety.

From the standpoint of conservation the adoption of a uniform system of irrigation metering is to be recommended. By preserving the supply, not only does the water user reduce the cost of irrigating his own lands, but the quantity of water saved makes possible the reclamation of additional lands, thus increasing the total area responsive to cultivation.

First Step Is Made in Mathematical Analysis of Capacity of Single Track

Study of Effect of Number and Location of Passing Sidings Results in Formulas Covering Trains of One Class and Rate of Speed

THE proper location of passing sidings along single track, and its effect on the capacity of line, has been under investigation during the last year by the committee on signals and interlocking of the American Railway Engineering Association in connection with the study of the problem of signaling single track. The committee makes no final report on the subject, but offers as a progress report the substance of an analysis by F. L. Dodgson, consulting engineer, General Railway Signal Company, who has been co-operating with the committee. Thus far the study has been confined to trains of one class and rate of speed. The discussion is printed here, however, slightly condensed, as suggesting a method of attack which is to be developed to cover trains of all classes.

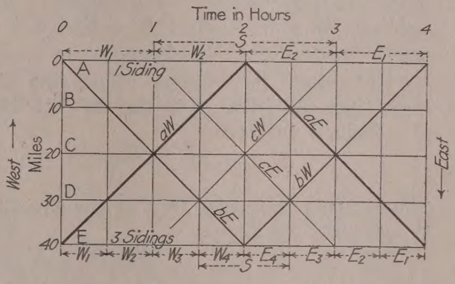


FIG. 1—LEVEL TRACK, 40 MILES LONG, UNIFORM SPEED OF 20 MILES PER HOUR FOR ENTIRE RUN

In considering the effect of passing-siding locations on the capacity of single-track railroad, it would seem to be the most logical thing to determine first, if possible, what rule or rules, if any, must be followed in order to locate the sidings so that the maximum capacity of the road will be obtained. Let us first assume a piece of level railroad 40 miles long over which we are to operate one class of trains only, these trains traveling at a uniform speed of 20 miles per hour. Fig. 1 is a train diagram of such a road, with the distance the vertical lines and the time the horizontal lines. If there were no sidings on this road, two trains could be run (one in each direction) each four hours during the day. These two trains are shown on the diagram by the two heavy lines *aW* and *aE*.

If, now, we assume that there is one passing siding on the road, it is quite evident that the maximum capacity would be reached with this located exactly in the center of the road. With this arrangement two additional trains could be run each four hours, and they are shown on the diagram by the lines *bE* and *bW*. If we represent the time required for the westbound train to run from E to C (C being the siding location) by W_1 and the time for the same train to run from C to A by W_2; likewise the time required by the eastbound train to run from A to C by E_2, and the time to run from C to E by E_1; and represent by S the spacing in time between trains running in the same direction; we will find that

$$S = W_2 + E_2 \qquad (1)$$

$$\text{and} \quad S = W_1 + E_1 \qquad (2)$$

$$\text{therefore} \quad W_2 + E_2 = W_1 + E_1 \qquad (3)$$

or, the sums of the running times of an eastbound and a westbound train between sidings are equal.

Now let us add two more passing sidings. Again it is obvious that the maximum capacity will be obtained if these two are located midway between A and C, and C and E. If, as before, we represent the running time of the westbound train from E to D by W_1, D to C by W_2, C to B by W_3, and B to A by W_4 (B and D being the locations of the two new sidings); and also the running time of the eastbound train from A to B by E_4, B to C by E_3, C to D by E_2, and D to E by E_1; and as before make S the time spacing between trains in the same direction; we will find from the diagram that

$$S = W_1 + E_1 \qquad (4)$$

$$S = W_2 + E_2 \qquad (5)$$

$$S = W_3 + E_3 \qquad (6)$$

$$\text{and} \quad S = W_4 + E_4 \qquad (7)$$

therefore

$$W_1 + E_1 = W_2 + E_2 = W_3 + E_3 = W_4 + E_4$$

This last equation stated in words again means that the sums of the running times of trains in opposite directions between passing sidings are all equal.

From Fig. 1 it will appear, therefore, that the maximum capacity of the railroad, with a given number of passing sidings, would be reached when the sums of the running times of the eastbound and westbound trains between passing sidings were all equal.

By adding equations 1 and 2 we have

$$2S = W_1 + W_2 + E_1 + E_2 \qquad (8)$$

or, representing $W_1 + W_2$ by W, the total running time of the westbound train, and, similarly, $E_1 + E_2$ by E,

$$S = (W + E) / 2 \qquad (9)$$

which is the value of S when there is only one passing siding.

Again, if we add equations 4, 5, 6 and 7, we have

$$4S = W_1 + W_2 + W_3 + W_4 + E_1 + E_2 + E_3 + E_4 \qquad (10)$$

$$\text{or} \quad S = (W + E) / 4 \qquad (11)$$

If we let N equal the number of passing sidings, then, in equation 9, $2 = N + 1$, and, in equation 11, $4 = N + 1$. Therefore, by substituting N in equations 9 and 11 for the number of sidings, we obtain the formula

$$S = \frac{W + E}{N + 1}$$

In deriving the above formula we have

VARYING AND UNEQUAL RUNNING TIMES

Distance, miles	Westbound, minutes	Eastbound, minutes
0 to 10	27	30
10 to 20	27	24
20 to 30	51	27
30 to 40	39	27
Total	144	108

assumed uniform and equal speeds of trains. In order to show an application of this formula and also to prove its correctness, let us assume varying and unequal speeds. Let us assume the running times to be as given in the table.

Now in Fig. 2, plot the line aW, using the time for westbound trains shown in the above table, and from the point where this line crosses line A plot the line aE, using the time shown for eastbound trains in the same table. First, let us assume one passing siding. Then in our formula,

$$S = \frac{W + E}{N + 1}$$

$W = 144$, $E = 108$ and $N = 1$, which gives the value, $S = (144 + 108) / 2 = 126$ min.

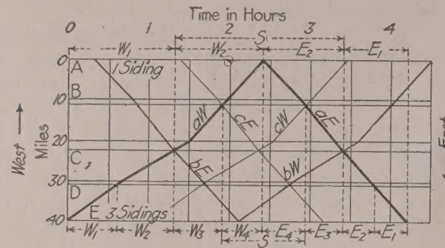


FIG. 2—TRACK NOT LEVEL, RATES OF SPEEDS VARYING ON DIFFERENT PARTS OF LINE

Now in Fig. 2, we will plot the line bW 126 min. from aW and parallel with it, and will also plot the line bE 126 min. from aE and parallel with it. Then aE will cross bW, and aW will cross bE on the same horizontal line, because the two triangle-like figures formed on the line E as a base by the lines aW and bE, and bW and aE have the same length of base, and their other corresponding sides parallel with each other and must, therefore, be the same in height. If the passing siding is located at the line C it is evident that we will again have the maximum capacity of this piece of road under the conditions given; and it is also true that the sum of the running times between A and C of the westbound and eastbound trains is equal to the sum of the running times of the same trains between C and E.

Now let us add two more passing sidings. From our formula we find that under these conditions $S = (144 + 108) / 4 = 63$. If on Fig. 2 we plot the line cW parallel with and 63 min. from aW and the line cE parallel with and 63 min. from aE, we will establish the positions of the passing sidings B and D at the points where these two lines intersect the lines bE and aE, aW and bW. As before, this arrangement gives the maximum capacity, and the sum of the running times between A and B is equal to the sum of the running times between B and C, etc. The rule, therefore, holds true when the running times are unequal and speeds not uniform.

While the method just pointed out in Fig. 2 will answer admirably as a graphic method of determining the locations of passing sidings for maximum capacity, it will not answer for determining the capacity of the railroad, because we have not taken into account the time lost by a train which takes a siding to meet another train, nor the time required for water stops.

Starting again with a uniform speed of 20 miles per hour, let us assume on our 40-mile stretch that there is a water stop at mile post 15, and further let us assume the total time lost in taking water by each train to be 12 min. The total running time, therefore, of each train would be 2 hr. 12 min. Further, let us assume that the time lost by a train taking a passing siding for another train to pass is 9 min. and that one-half of this time is consumed in entering the siding and one-half in leaving, and let us also assume that the eastbound train takes the siding. Fig. 3 shows the train diagram for such an arrangement with one passing siding.

If we let S equal the spacing between trains in the same direction, the number of trains per day, represented by T, will be $T = 1440 \times 2 \div S$ (1440 being minutes in a day and S being expressed in minutes), or $T = 2880 / S$.

We may determine the value of S as follows: Assuming that W_2 represents the time of the westbound train running between the passing siding and 0, and W_1 the time running between the passing siding and 40, and E_2 the time consumed by the eastbound train in running between 0 and the passing siding, and E_1 the time between the passing siding and 40, and also letting a represent the time consumed by a train taking the passing siding to meet another train, we have from the diagram

$$S = W_1 + E_2 + a/2 + a/2$$

also $$S = W_2 + E_1 + a/2 + a/2$$

adding, $$2S = W_1 + W_2 + E_1 + E_2 + a + a$$

or $$S = W + E + 2a.$$

If N equals the number of passing sidings, then substituting in the last equation $T = 2880/S$ we have

$$S = \frac{W + E + (N + 1)\,a}{N + 1}$$

Substituting this value of S in the equation $T = 2880/S$ we have

$$T = \frac{2880\,(N + 1)}{W + E + (N + 1)\,a}$$

It will be seen that, up to this point, there have been developed methods of finding the proper locations of passing sidings for trains of one kind and determining the capacity of a given piece of single-track road in trains of one kind. It is expected that formulas or methods will be developed for determining capacity in trains of one kind as affected by the movement of a given number of trains of other kinds run on definite schedules. Then the various formulas will be applied and tested in the analysis of actual pieces of road with their actual movement of scheduled trains.

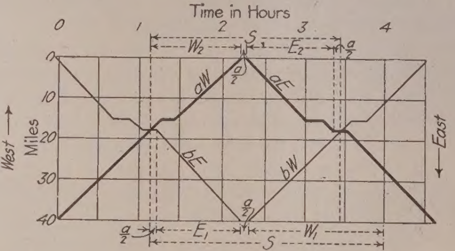


FIG. 3—ACCOUNT TAKEN OF WATER AND PASSING STOPS FOR TRAINS WITH UNIFORM SPEED

Monolithic Brick Road Built on Old Macadam Base

Cost of $1.06 a Square Yard Reached in Spite of Hand Methods Required by Small Size of Job

A PORTION of an old macadam roadway in Godfrey township, just outside of Alton, Ill., was paved in the fall of 1915 with brick laid in a 2-in. dry cement mortar bed on the leveled surface of old macadam roadway. Accurate cost data were kept on this construction. The method of construction is said to have proved very satisfactory.

After grading was completed and the forms set a 2-in. base of a dry mixture of cement and sand in the proportions of 1 part of cement to 4 parts of sand was placed between forms and then leveled and rolled. The brick used are known as "highway pavers" or "No. 1 light" brick, which will show an average rattler loss of about 25 per cent. These brick were laid upon the base and rolled with a hand roller. The surface obtained in this way was exceptionally even. The brick were then flooded with an amount of water sufficient to saturate the sand-cement base, and the joints between the brick filled with a grout consisting of equal parts of sand and cement thoroughly mixed.

COSTS

The paved strip was 446 ft. long and 14 ft. wide, containing 693.8 sq. yd. Sand cost $0.82 per ton and cement $1.35 per barrel, net. Common labor received $0.20 per hour and the foreman $3 per day. The water cost nothing, but the depreciation on pipe and the cost of connecting the water line are included in the figures given below. The roller for the subgrade was loaned, but the wages of the operator, $2.50 per day, were included in the cost data. A team with driver cost $6 per day.

The itemized cost was as follows:

Item			Total cost	Cost per sq. yd.
Labor:				
Grading, setting forms, building barricade			$58.45	$0.084
Mortar base and laying brick			60.73	.087
Filler			18.50	.027
Labor total			$137.68	$0.198
Base:				
57.32 tons sand at $0.82		$46.93		
54 bbl. cement at $1.35		72.90		
3 cement sacks short		.30		
			120.13	.173
Filler:				
5 tons sand at $0.82		$4.10		
25 bbl. cement at $1.35		33.75		
			37.85	.054
Forms:				
992 ft. 2 x 6 x 12, at $20, assuming salvage 67 per cent		$6.66		
14 ft. double template, 60 oak stakes		6.05		
Steel stakes		.85		
Nails		.35		
			13.91	.02
Miscellaneous:				
800 ft. No. 9 wire $3, salvage, 50 per cent		$1.50		
Staples		.15		
6 red lanterns	$4.50			
2 extra globes	.40			
	$4.90			
Salvage 50 per cent	2.45			
		2.45		
1 water bucket		.25		
1 sprinkler		.60		
25 per cent depreciation on shovels, squeegees, etc.		13.50		
Depreciation water line		6.00		
Teaming tools, etc		2.00		
			26.45	.038
Finishing:				
2 teams with drivers one day			12.00	.017
Brick			338.58	.56
Final total			$736.60	$1.06

An effort was made to include a generous provision for depreciation. The size of the job necessitated hand mixing and in other ways increased the cost of the job over the unit costs that could be obtained for a larger one. The final cost per square yard does not include any contractor's profit but otherwise is thought to represent accurately what a road of this type can be built for in the vicinity of Alton. The resulting pavement is subjected to a heavy traffic leading from Alton toward the north. The low cost of this heavy-traffic road is expected to result in other roadways of the same type being built in this vicinity.

Committees of American Railway Engineering Association Complete Another Year of Work

Abstracts of Reports Made to the Annual Convention of the Association, Which Meets in Chicago This Week

[Following its custom, there is here presented a summary of the reports made by its committees to the American Railway Engineering Association, in convention in Chicago this week. These reports have been appearing in the association's bulletins during recent months. Comment is necessarily brief. More extended abstracts of some of the reports will appear in subsequent issues. Since this summary is prepared in advance of the convention it necessarily takes no account of action on the respective reports.—EDITOR.]

Roadway

Progress only is reported by the committee on roadways. A circular letter and list of quotations have been sent out pertaining to steam shovels, mechanical excavators, and similar equipment, but the committee withholds reporting on this until more replies have been received.

Some further work has been done by the subcommittee investigating allowable unit pressures on roadbed of different materials, but the committee is not yet ready to report on the subject. The subcommittee investigating the prevention and cure of water pockets in roadbed desires to await the demonstration of the efficiency of the remedies adopted before drawing conclusions. The subcommittee on revision of the *Manual* points out that the 24-in. depth of ballast for class A track will require a width of subgrade of approximately 26 ft.

In further explanation of the subject of haul and overhaul discussed in last year's report of the committee, two monographs —"The Profile of Quantities," by S. B. Fisher, and "The Overhaul and Distribution Diagram," by J. R. W. Ambrose, are submitted. (Bulletin 183.)

Ballast

The committee on ballast offers for adoption the following order of efficiencies of ballast: (1) Stone, (2) broken slag (not granulated), (3) gravel, (4) chats, (5) burnt clay or gumbo, and (6) cinders. The committee states its belief that the efficiency of gravel for ballast is much improved by washing, because this removes undesirable materials, and because if the plant is properly arranged the desired per cent of each size of gravel can be secured during the process of washing.

Reports from three railroads on the use of the pneumatic tamping machine are presented, but the committee is unwilling to make definite recommendations regarding the machine. The committee presents pictures and data regarding ballast "formers"; it concludes that "formers" results in considerable economy, but that specific data have not yet been obtained to make a complete report.

Regarding ballasting by contract, the committee has had much difficulty in obtaining good comparative figures, but is convinced that under certain conditions the method is satisfactory and more economical than ballasting by company forces.

The subcommittee investigating the economical and efficient depth of ballast has continued its study, and has obtained reports from ballast tests on various railroads under federal valuation. These investigations indicate that there is a much greater depth of ballast actually existing in track than has previously been supposed, and that while many standard plans show 12-in., the actual depth in main line is much greater. The committee recommends a minimum depth for class A track of 24 in. under bottom of tie on fills, and 12 in. through rock cuts or on material which will not be deformed by the application of live loads. The committee again unanimously recommends that the test outlined in the 1913, 1914 and 1915 reports be made under regular traffic.

Three appendices are presented, one on stone ballasting by contract, by John Evans, of the Michigan Central; one on the efficiency of various stone and gravel ballasts, and one on the gravel washing plan of the Brook Haven Gravel Company, at Brook Haven, Miss. (Bulletin 183.)

Ties

A set of specifications for switch ties, and a revised set for crossties to be substituted for those now in the *Manual* are offered by the committee on ties. The revised specifications for crossties change the classifications of woods to some extent, and involve certain changes in methods of handling.

On the subject of the effect of tieplates and track spikes on the life of crossties, the committee states that the practice of railroads is anything but uniform, and that the methods of properly protecting the tie are going through rapid changes, which make it difficult for them to say definitely as to the effect on the tie of any particular part of the design. The committee feels that no definite practice can be presented as having been developed to such an extent that it should be adopted, but it illustrates what it calls certain tendencies of good practice and directs particular attention to the necessity of reducing or eliminating, if possible, movement between the tieplate and the tie. Standards and other data of a number of railroads are presented.

Twenty-two pages are given to new data compiled on the use of metal, composite and concrete ties. (Bulletin 182.)

Rail

Taking both the committee report and related papers unusual attention is given to the subject of rails. No changes in the *Manual* are suggested, except that certain specifications now embodied in the *Manual* under the chapter on track are to be withdrawn and new ones substituted. These specifications cover quenched carbon and quenched alloy-steel joint bars, quenched carbon and quenched alloy-steel track bolts with nuts, and for medium carbon-steel track bolts with nuts.

Statistics of rail failures, for the period ended Oct. 31, 1914, are presented, and show that the number of failures of rails rolled in successive years since 1908 has decreased. Failures of Bessemer rails are double those of open hearth.

No conclusions have yet been reached on the effect on rails of defective equipment and improper maintenance. The committee states that it will not be able to make any definite report until the joint committee on stresses in railroad track is prepared to go extensively into the matter of making experiments to develop just what the effect of bad flat spots on wheels is on the rail.

There are appendices on "American Rail Mill Practice," and on "Internal Fissures in Rails." (Bulletin 184.)

Track

For adoption and publication in the *Manual* the committee on track recommends a design for a double switch lug; typical layouts (general plans) of Nos. 8, 11 and 16 double crossovers, 13 and 15-ft. centers; typical layouts for frogs for same; typical layouts of Nos. 8, 11 and 16 double slip crossings with square and with staggered switch points, and a typical plan of frog guard rails. The committee also recommends for adoption its report on the relation between worn flanges and worn switch points. The committee believes that neither the rule suggested last year nor any other rule will, even in a remote sense, cover the conditions aimed at, and asks that it be relieved from further consideration on the subject.

The subcommittee on economics on track labor, while reporting progress only, points out the magnitude and importance of the subject and hopes that it may be permitted to continue its investigation without taking on any other work. Last August a circular was sent out to roads not reporting special records of track sections, and the committee hopes that these roads, as well as the eighteen from which records of test sections have been received, will produce much valuable information.

Progress is reported by the subcommittee investigating specifications and designs for cut and screw spikes. Certain changes in the specifications for the former are proposed.

The committee recommends that the study of increased thickness of wheel flange, design of manganese frogs and crossings, and the action of brine drippings on tieplates be continued. Tests of the effect of brine drippings are soon to be conducted in the yards of the Chicago Junction Railway at the Union Stock Yards. (Bulletin 183.)

Buildings

One change in the *Manual* is recommended by the committee on buildings. Under the item "engine houses," it is recommended that engine houses where there is no means of turning engines be equipped with smoke jacks at each end of each stall.

A page of rules regarding freight-house scales and three pages, illustrated, regarding ash pits are offered. Where a large number of engines are handled the committee recommends the water-type pit, with locomotive or gantry crane with grab buckets. (Bulletin 183.)

Wooden Bridges and Trestles

The committee on wooden bridges and trestles submits six pages of discussion of the design of docks and wharves, together with five pages of drawings showing typical designs. The committee points out that there are few wharves and docks now being built which are not partly or entirely of steel and concrete, and the committee has assumed that these should be included in the investigation.

Abstracts of replies from about fifty railroads relative to the comparative merits of ballast-deck wooden and reinforced-concrete trestles are presented. Data are also presented concerning the use of lag screws for fastening guard timbers. In view of the fact that a comparatively small number of roads have used lag screws, and that a few have abandoned their use, the committee does not yet feel justified in recommending their adoption, in spite of the very general satisfaction expressed by some of the roads using them.

The committee recommends that it continue all three of its investigations for another year, and that it investigate the merits of galvanized iron fastenings for timber trestles, especially creosoted structures.

The committee mentions a communication from E. P. Goodrich suggesting a modification of the association's specification to admit piles near enough straight so that a line held in contact with any two points selected so as to give the maximum deviation shall not be distant from the surface of the pile at any point more than the diameter of the pile at that point. The committee believes, however, that the present specification should be retained, which requires that a line from center of butt to center of tip shall lie with the body of the pile. (Bulletin 182.)

Masonry

Specifications for the construction and driving of premolded concrete piles, together with a brief discussion of them, are offered by the committee on masonry. Patented cast-in-place concrete piles were not considered.

A five-page report on the appearance, wearing qualities and cost of various methods of surface finish of concrete is presented. This includes specifications for rubbing with carborundum or cement bricks, for rubbing with wooden floats and for washed or scrubbed surfaces, together with four conclusions for adoption in the *Manual*. The gist of the conclusions is that the spaded finish is the most durable and economical for work not requiring decorative treatment, and that bush hammering or other tool work gives the best appearance. Coating with a wash of cement is not recommended. Rubbing with carborundum bricks or wood floats is next to spading in ease of application and cost.

Regarding the design of foundations in various soils and depths of water, the committee has confined itself to the searching of records as to the general practice of investigating the carrying capacity of foundation soils. Answers to questions submitted to the membership and others are presented in tabulated form. In the near future the committee expects to prepare a form showing in what manner records of tests of foundation soils may be duly kept.

Brief reports of the activities of the Joint Committee on Specifications for Cement and the Joint Committee on Concrete and Reinforced Concrete are presented. The members of the latter committee desire the association to decide whether steel reinforcing bars rolled from steel rails are recommended, whether they are recommended provided they are used only when they do not need to be bent, and whether they are recommended for use under the same conditions as bars rolled from billets under the requirements of the specifications for high carbon steel of the American Society for Testing Materials. (Bulletin 182.)

Signs, Fences and Crossings

Following the objection raised to the old conclusions relative to track construction and flangeways at paved street crossings and in paved streets, the committee on signs, fences and crossings has gone into the matter at considerable length, and gives an extensive discussion of the subject in its report. The committee has reached the conclusion that two distinct conditions are to be met, and that three distinct forms of construction are desirable. For paved street crossings it is recommended that the regular standard track construction be used and the space occupied by the track or tracks be planked over. A plan is offered for light traffic and another for heavy. For tracks located in paved streets subject to heavy traffic, requiring granite block paving, the committee believes the construction should consist of stone or gravel ballast not less than 12 in. deep, treated ties and 141-lb. 9-in. girder rail; for tracks in streets subjected to light traffic only, standard track construction, using treated ties and stone or gravel ballast, the space occupied by the tracks to be paved to meet municipal requirements.

The committee found a variety of schemes for providing flangeways at road and street crossings and in paved streets, and it recommends that further study be made to determine the proper flangeway through crossing frogs where steam railroad tracks are crossed by trolley tracks.

The committee feels that it has exhausted the subject of concrete fence posts, but believes the matter of signs should be investigated with a view to reducing the number and adopting a standard for general use. It believes their location should also be considered. The committee also recommends that the legal requirements relative to fencing right-of-way and providing stock guards be investigated. (Bulletin 181.)

Signals and Interlocking

The committee on signals and interlocking presents a seven-page discussion of the capacity of single track which is offered as a progress report. It also submits for adoption a page of findings of the Railway Signal Association.

Because the main controlling power of signal apparatus is electrical and because the special training required is so different, the committee does not believe it is desirable to combine signal and track forces in signal maintenance. Occasionally it will, in the estimation of the committee, be found practicable and economical to combine forces engaged in maintaining various electrical features with those maintaining signals, but as a general proposition, economy and efficiency will be produced to a higher degree by co-operation and by combination. (Bulletin 181.)

Records and Accounts

Several symbols to be substituted for those now in the *Manual* are suggested by the committee on records and accounts. The committee also submits the two-page alphabetical index covering the list of conventional signs.

A page of matter is devoted to methods for reproducing maps and profiles on drawing linen for permanent record. The ordinary processes are mentioned, and brief descriptions are given of four others, the photographic, the hectograph, the planograph and the lithographic.

The committee reports progress in its investigation of the use of small forms on cardboard. (Bulletin 183.)

Water Service

The committee on water service offers nothing for inclusion in the *Manual*, but submits as information a short discussion of the cost of pumping water by various methods, together with five extensive tables compiled from data received from a number of railroads. It also presents as information a five-page discussion of protection for water stations against freezing. (Bulletin 181.)

Yards and Terminals

One new definition, that of a "holding yard," is offered by the committee on yards and terminals for adoption in the *Manual*. Progress is reported on the investigation of the handling of freight in double-deck freight houses, but the committee is not yet ready to submit its report.

During the last year the committee has observed the results obtained by the use of two of the methods for studying the working capacities of stations and approach tracks referred to in its report for 1912. The committee reports that the methods used at the Broad Street Station at Philadelphia and at the new Union Station in Kansas City have proved very satisfactory. The committee's co-ordinate train-diagram and track-occupancy diagram used at Kansas City just subsequent to the opening of the new Union Station for the purpose of scheduling trains on the proper tracks, permitted a reasonably accurate forecast to be made of the best schedule for accomplishing the loading and unloading of trains and the transfer to and from trains, also of obtaining the most efficient use of the throat tracks during the rush hours.

Studies of the operation of two hump and one flat yards for a month last year were made, and comparative results are presented in tabulated form.

Recommendations for the design, construction, maintenance and operation of railroad track scales, which have been submitted to the committee on weighing of the American Railway Association and conform in general with its "track-scale specifications and rules," are presented for consideration, but the committee does not ask that they be adopted in the *Manual* this year. (Bulletin 182.)

Iron and Steel Structures

Six subjects, including the revision of the *Manual*, were assigned to the committee on iron and steel structures. The committee believes all of them are worthy of much further investigation, and makes no final report on any of the six. Short progress reports are submitted by the subcommittee investigating methods of protection of iron and steel structures against corrosion, that investigating column tests, and that studying the relative economy of various types of movable bridges. A nine-page report of the subcommittee studying the design, length and operation of turntables is confined to a discussion of phosphor bronze for use in turntables and movable bridges. This discussion includes specifications for bronze bearing metals, a bibliography of hardness testing, a discussion of particular uses of bronze in movable bridges and a table of the composition and physical properties of bronzes.

A 25-page discussion of working stresses for bridge structures is submitted, the committee expressing the earnest hope that the proposed changes in bridge specifications will receive liberal discussion, and that at the next annual convention final conclusions may be presented for adoption.

The requirements for the protection of traffic at movable bridges, which had been in the hands of the committee for two years, have been the subject of further consideration. A résumé of the subject was published in *Bulletin* 178, and the committee recommends for adoption the specification printed on page 274 of that bulletin. It also recommends for adoption three additional specifications submitted by a committee of the Railway Signal Association. (Bulletin 178.)

Economics and Railway Location

Progress only is reported by the committee on economics of railway location. Some work has been done and subcommittee reports considered. While the results are instructive it is not thought advisable to publish them at this time.

The chairman of the committee, J. G. Sullivan, made a careful study of the statistics of coal consumption in freight service on the Western lines of the Canadian-Pacific Railway for the past eight years. These studies have convinced him that instead of attempting to base coal consumption directly on the amount of work done it is better to divide the coal into two factors; one varying directly with the amount of work done and the other with the engine-miles run. As a result of these studies the following formulas have been adopted for Western lines of the Canadian-Pacific Railway:

Single-track operation—fairly busy lines, 3.5 lb. coal per calculated horsepower hour, plus 50 lb. per engine-miles run.

Double-track operation—3 lb. coal per calculated horsepower hour, plus 60 lb. per engine-miles run.

The above figures are an average for the year, for conditions on the Canadian-Pacific Railway, Western lines, using engines equipped with super-heaters and having drawbar pull varying from 36,000 to 42,000 lb. each. (Bulletin 184.)

Wood Preservation

Much time has been given during the year to the investigation of tests for determining a standard method of finding the percentage of water contained in creosote oil when shipped in tank cars. In conjunction with committees of the American Society for Testing Materials and the American Wood Preservers' Association a very complete experiment was carried out. The results of the test, however, are presented only as a progress report. Preliminary conclusions, however, are advanced as to the correct method of securing a sample for tests. Among these preliminary conclusions is the suggestion that a certain type of sampling apparatus, illustrated in the report, be used for taking quantities in different zones in the cars.

Assigned to the committee last year was the subject of the relation of the amount of preservative and the depth of penetration to the resistance of the material against decaying. The committee has studied the service tests available in the light of this problem. It finds, however, that while the amount of preservative and the factor of decay are noted, there is no information on the depth of penetration. It is not yet able to report any conclusions whatsoever, but will continue its investigations this year. It raises the point as to the relation of mechanical abrasion in connection with the relation between depth of penetration and protection against decaying. It states that the records of timbers and piling that were not exposed to mechanical wear and in which the impregnated wood extends from ½ to 2 in. on the outside indicate that complete penetration is not necessary if the outer protective rings remain unbroken, and the ends are likewise protected. On the other hand, there is a very definite record of ties which have resisted decay until abrasion under the rail cut through the treated portion. As soon as this happened decay commenced and necessitated the removal of the ties which were otherwise in good condition.

Appendix A gives the record of service tests on different railroads under various conditions. (Bulletin 184.)

Electricity

A page of additional data regarding third-rail clearances and four pages regarding overhead clearances have been compiled and are presented by the committee on electricity.

The committee reports that the National Joint Committee on Overhead and Underground Line Construction has not yet completed its work on the revision of the crossing specifications, or completed any other new specifications. The association's delegates were actively engaged with the committee on the preparation of the revised crossing specifications when the progress of the joint committee was stopped and held in abeyance by the fact that the U. S. Bureau of Standards was about to issue a safety code which included specifications for crossings.

The committee's three representatives on the National Joint committee on electrolysis state that they have no report to make until the joint committee prepares its report. No meeting of the joint committee was held during 1915, but subcommittees have been at work preparing various sections on the report.

Nothing new is reported on the subject of installation, maintenance, water power for electrical railway operation, or maintenance organization and relation to track structures. (Bulletin 183.)

Conservation of Natural Resources

A seven-page progress report is submitted by the committee on conservation of natural resources. This includes a discussion of forestry abroad, one on wasted hydroelectric power and one on the results of electrical operation in the Northwest. On account of the war in Europe, the Conservation Association of the United States has done no work for two years, while both federal and state conservation work has been suspended, so that no progress report of work done by other conservation associations can be given. (Bulletin 182.)

Uniform General Contract Forms

A form of agreement for industry tracks is the principal offering of the special committee on uniform general contract forms. Conceding that widely different conditions, federal and state regulations and other circumstances may prevent the wide adoption of the form as a whole, even when approved by the association, the committee believes, nevertheless, that the form will be of value as a compilation and adaptation of what are regarded as the more important provisions which should be incorporated in such a document as circumstances may require.

Following a critical review of the adopted contract form, the committee recommends certain changes pertaining to bond, timely demand for points and instructions, inspection, insurance, intoxicating liquors and annulment.

Progress is reported as to forms for interlocking and railway crossing agreements. (Bulletin 182.)

Grading of Lumber

The special committee on grading of lumber calls attention to the rule adopted by the American Society for Testing Materials establishing two classes of Southern yellow pine, called "dense" pine and "sound" pine. The special committee has co-operated with the American Society for Testing Materials, and with the investigations made by the U. S. Government, and it recommends the acceptance of the definition for Southern yellow pine adopted by the American Society for Testing Materials.

The grading rules for hemlock lumber presented last year in Bulletin 174 have been revised to some extent, and the committee recommends that they be adopted as revised.

The committee states that it has been at work, in co-operation with the American Society for Testing Materials, with a view of preparing specifications for bridge timbers to be creosoted. The committee is unable, however, to indorse the tentative recommendation made by the committee of the American Society for Testing Materials. It believes that specifications for timbers to be creosoted, as far as the quality and strength are concerned, should be similar to those for timbers to be used untreated, with the exception of the relation of heartwood and sapwood. On this basis the committee has prepared specifications which it presents as information; they are simply the standard specifications for structural timber as printed in the *Manual* with all reference to the requirements as to heartwood and heart face omitted, and a clause permitting sapwood to be substituted for the heart requirements. (Bulletin 183.)

Stresses in Railroad Track

A short progress report is submitted by the special committee on stress in railroad track. It contains about the same information as that of the committee of the American Society of Civil Engineers presented at the annual meeting of that society in January. Field tests have been conducted on the main line of the Illinois Central Railroad north of Champaign, Ill. Data were taken to determine (1) the distribution of stresses and moments along the rails for a given loading, (2) the division of vertical load among adjacent ties for a given loading, (3) the distribution of vertical pressures among the ties, through the ballast and over the roadbed, (4) the depression, compressibility or thickness of the track, (5) the effect of wheel spacing of some types of locomotives and also the effect of single and double concentrated loads, (6) the effect of speed from most of the foregoing items. Tests have been conducted at 65 miles per hour. Among the variables of the track were three weights of rail, two sizes of ties and three depths of ballast. In addition to tests on standard track, minor tests have been made at spots where uneven tie spacing or worn or decayed ties might effect the stresses developed.

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STARTING TO CUT OUT CENTER OF OLD DRAW BRIDGE

Considerable progress has been made in the development of instruments for determining the stresses. This has required considerable painstaking experimental work, and the calculation and compilation of the results of the test have also proved to require a great deal of time. The data are now being put into shape, and it is expected that the results will be ready soon for the consideration of the committee. Meanwhile the committee plans to continue the tests during the coming season, to complete the matters already partly covered and to extend the experiments to include other features, like action on curves and on tracks of different kinds. It proposes to report soon to the association the results of the tests already carried out. (Bulletin 182.)

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BY THE NEXT NOON THE CENTER SPAN HAD BEEN REMOVED

Double-Deck Trunnion Bascule Bridge Put Into Use

Central Portion of Thirty-Year-Old Center-Pier Draw Span Cut Out with Oxyacetylene Torches in 1½ Days at Chicago

LESS than four days' time was required to replace the old double-deck, center-pier, iron draw span across the Chicago River at Lake Street with the new double-leaf, double-deck trunnion bascule bridge. The new bridge is 245 ft. 3 in. long between the centers of the trunnions and 70 ft. wide over all. It was erected around the old structure, while traffic on the Chicago & Oak Park Elevated line was maintained through the new leaves which were erected in a vertical position.

The program for the shift from the old bridge to the new was as follows: On Saturday, Feb. 26, at midnight, the elevated traffic was stopped over the old span and the elevated company immediately proceeded to remove the rails. The lower roadway deck had been closed during practically the whole period of erection.

On Sunday, Feb. 27, at 6 a. m., the draw span was swung into the river position and blocked up on falsework. The center portion of the old span interfering with the lowering of the leaves of the new bridge was then burned out utilizing several Oxweld acetylene torches. The sections were removed by a crane on a barge, and by noon the next day all that remained were the ends resting on the piling. The old panels of the elevated structure on each side of the river were removed and in the meantime floorbeams and stringers were placed in two panels of each leaf of the new bridge which had been omitted during construction to allow the passage of elevated trains.

While these operations were taking place the old viaduct just west of the bridge was moved south, transversely, about 4 ft. to allow the construction of the north leaf of the new viaduct in its final position. To permit uninterrupted elevated traffic during the construction of the new viaduct, an additional track will be placed on falsework south of the viaduct.

The whole of the center span panel had been removed by Monday noon and adjustments and alignments of the new leaves started. Various specified trial operations of the leaves were carried out Monday and Tuesday, until the center locks, rear locks, anchorage bearings, supports on the river piers, brakes and other portions of the operating machinery worked satisfactorily.

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ENDS OF THE OLD SPAN WILL BE CUT UP AT LEISURE

Ties had already been placed on such portions of the new leaves as had been possible. Tuesday night the elevated company put down the rails and the new bridge was ready to care for traffic Wednesday.

The Fitzsimons & Connell Dredge & Dock Company with P. G. Connell, superintendent, was the contractor for the substructure, which was begun in March, 1914, and completed in April, 1915. The contractor for the superstructure was the Keller-Elliott Erection Company, for which George Hoersch is superintendent.

The work was carried out under the general direction of John Ericson, city engineer. Thomas G. Pihlfeldt is bridge engineer, Alexander Von Babo, engineer of bridge design; Clarence S. Rowe, assistant engineer of bridge construction, and William A. Mulcahy, assistant engineer in local charge.

EXCAVATION FROM THE BASES of the Culebra slides of the Panama Canal during the week ending March 6 amounted to 246,011 cu. yd., according to a report in the *Canal Record*.

Recommend Both Reservoirs and Levees to Protect Columbus from Floods

Alvord & Burdick in 400-page Report Find Cost $10,125,000 for Project Caring for Flood 45 Per Cent in Excess of 1913

PROTECTION from a flood in the Scioto River 45 per cent greater than that of 1913 can best be obtained by the Franklin County Conservancy District, Ohio, in which Columbus, Delaware and Chillicothe are located, by a combination of two unusual detention basins and channel improvements, according to a 400-page typewritten report recently submitted by John W. Alvord and Charles B. Burdick, of Chicago, chief engineers for the district. The following notes are taken from the general conclusions of the report. One of the reservoirs is on the Scioto River above Dublin, and one on the Olentangy River above Delaware. The cost, estimated at $10,125,000, includes the lands, a special $1,000,000 benefit to Columbus in the way of a water supply for the next 75 to 100 years, and numerous bridges and street improvements throughout the county.

FLOOD DATA CONCLUSIONS

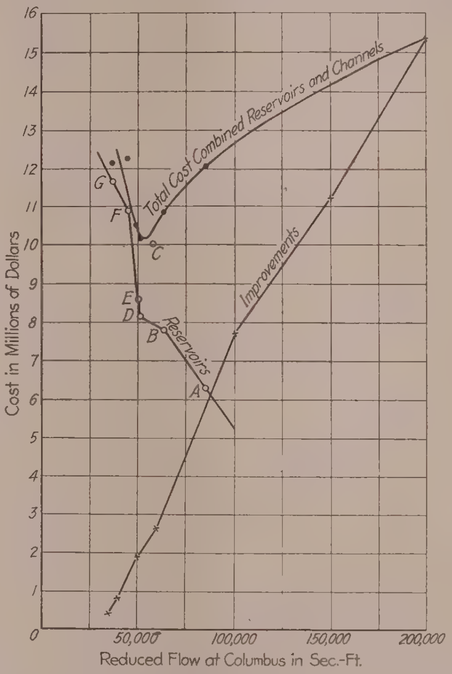
The size of the basins is such as to hold back, at Columbus, all water above 50,000 sec.-ft., the channel-capacity to be provided for through the city. The maximum runoff is taken as 200,000 sec.-ft., 45 per cent in excess of the 1913 flood, and the point of calamity would not be reached until the discharge had reached 250,000 sec.-ft. Records show that the 1913 flood is double the next greatest flood of the past 100 years. Owing, however to increased settlement and development of the valley at least six floods of record, some of which were not especially destructive, would, under present conditions, create a calamity in all probability equal to that of 1913. Flood menace, therefore, in the future is not to be measured wholly by the probability of a recurrence of the 1913 flood, but by the increasing menace of much smaller floods made dangerous by channel encroachments, combined with levees and other embankments. It is believed that in course of time the flood of March, 1913, will not only be repeated but probably exceeded, by reason of the following causes:

1. A rainfall of more than 6 in. in two days centered over the critical area below Prospect.
2. Greater rainfalls such as are on record elsewhere, centering over the whole watershed.
3. Snow accumulations melted by warm rainfalls of high intensity and duration over the critical area.
4. Gradual elimination, through improvement, of existing natural detaining basins, which on the Upper Scioto have hitherto aided in restraining excessive floods.

Taking these conclusions together it would seem the part of wisdom to provide, as a factor of safety, protective works which will prevent a calamity in a flood having at least one-half greater maximum flow than occurred in 1913. The safety of large storage basins further requires that there should be provided, as an additional factor of safety, liberal spillway capacity above this amount, capable of further fully protecting the proposed dams.

ADVANTAGES OF PROJECT SELECTED

Of the total cost approximately $2,500,000 is allowed for about 21,000 acres of detaining-basin land estimated as purchased outright. Inasmuch as practically all of this land may be continuously cultivated it will retain its agricultural value. Its cost should not be treated as entirely a burden to the taxpayers. Deducting the value of land which should be able to pay its own way, the value of water-storage capacity to Columbus, the cost of rebuilding certain structures which should be financed by the city and county, leaves about $6,000,000 as the cost of flood protection. Based on percentage of losses suffered during the 1913 flood, Chillicothe should pay 9.5 per cent; the 41,370 acres of farm lands, 10.1 per cent; Columbus, 54.7 per cent; Delaware, 3.7 per cent; the county, 6.3 per cent; the railways, 15.4 per cent, and the villages, 0.3 per cent. Water power cannot be profitably developed.



COST BALANCE BETWEEN PROJECTS FOR RESERVOIRS AND CHANNELS TO PROTECT AGAINST 200,000 SEC.-FT.

BASINS ARE LARGE

The project requires, on the Scioto River, a very large detaining basin, which will be formed by an earthen dam across the narrow valley above Dublin. The greatest height of the dam will be 143 ft. and its thickness at the base 980 ft. It will hold at spillway level 255,925 acre-feet of water and flood 9580 acres.

There will be conduits formed by tunnels in the solid limestone rock of the adjacent hillside. These conduits will be so arranged as to serve for both flood protection and water supply storage.

The project also requires a large detaining basin on the Olentangy River, about 2 miles above Delaware. This will be formed by an earthen dam 82 ft. in greatest height and 850 ft. thick at the base. It will hold at spillway level 163,202 acre-feet, and will flood 11,299 acres of land.

Two conduits tunneled in shale rock in the adjacent hillside at the river level will permit the ordinary flow to pass through the bottom of the dam.

Every precaution will be taken to provide for the safety of these dams. They will be founded on rock, will be made of extra thickness and will have ample spillways. Before they could be overtopped a flood more than three times as great as that of 1913 would have to occur. Put in another way, the spillway outlets will alone pass two and three-fourths times as much water as the maximum flow in the 1913 flood.

BALANCING CHANNEL AND RESERVOIR COSTS

It is evident that, other things being equal, the project is the best which safely passes a given flood with the least cost. Each project for reservoirs produces a different reduced flow, and, as in all these projects expenditures for channel improvements are necessary, the least cost is determined by adding to the cost of each reservoir project the cost of the channel improvements that would be required along with it. the curve marked total cost, shown herewith, represents the sum of each reservoir project with its corresponding channel improvement. It indicates very clearly that Project D, costing $8,210,712 for basins and $1,914,400 for channel improvements, a total of $10,125,112, is the most economical combination for accommodating a 200,000-sec.-ft. flood. This contemplates a channel improvement to accommodate about 50,000 sec.-ft.

Engineering for Reproduction Estimated in Detail

Missouri Commission in Mississippi River & Bonne Terre Case Works Out Campaign Instead of Using Lump Percentage

INSTEAD of adding an arbitrary percentage for engineering in estimating reproduction cost, W. W. K. Sparrow, assistant chief engineer of the Missouri Public Service Commission, in his appraisal report on the Mississippi River & Bonne Terre Railway (see the Engineering Record of Mar. 18, page 386) made a detailed estimate of what, in his opinion, would be all of the engineering work required in the construction of the road. Whether or not the accuracy of such an estimate for a large and complex railroad system would be sufficient to warrant its expense, the conditions here seemed to suggest the feasibility of such an estimate. The main line, on which this article is based, is 46½ miles long, and the estimated reproduction-cost new of the items covered by the road accounts of $2,373,507, suggests that there were probably no abnormal problems of engineering to be solved in building the road. It may be worth mentioning that the engineering as estimated figures practically 3 per cent of the estimated cost of the total for the construction accounts.

The section of Mr. Sparrow's report treating on the subject is substantially as follows:

Reconnaissance.—The main purpose for the construction of this line was to haul ore from the lead mines located at Bonne Terre, Doe Run and in the Flat River district. The governing points are therefore fixed at no great distance apart, and with the aid of the maps of the U. S. Geological Survey, the preliminary selection of a route

TABLE 1—PARTY FOR PRELIMINARY SURVEYS AND FINAL LOCATION

Locating engineer	$200
Assistant locating engineer	150
Topographer	125
Transitman	110
Levelman	100
Draftsman	100
Rodman	50
Head chainman	50
Rear chainman	50
Tapeman	40
Back flagman	40
Stake marker	40
Axemen (four at $35)	140
Cook	50
Camp helper	25
Team and driver (two at $100, furnishing own feed, drivers boarded)	200
Board	300
Total	$1,770

does not offer much difficulty. For this estimate the sum of $1,000 to cover the salary and expenses of an engineer for a period of two months is considered ample.

Preliminary Surveys and Final Location.—The composition and salaries of the locating parties used in making the estimate is as shown in Table 1. For the preliminary, or trial line, the estimate is based on 116 miles or 2½ times the main-line mileage. It is estimated that a party of the composition outlined would, in this character of country, make at least 1½ miles per day, making the cost of the preliminary surveys, 3 1/3 months at $1,770 equals $5,894, or $51 per mile. For the final location the estimated progress is figured at ½ mile per day; therefore four months at $1,770 equals $7,080. In addition to the salaries and subsistence of the party must be added the cost of the camp equipment and surveying instruments, which, after allowing for salvage, is estimated at $500. This makes a total cost of surveys of $14,474, or $310 per mile of road.

TABLE 2—ORGANIZATION OF CONSTRUCTION FORCE

Chief engineer	$300
Office engineer	175
Draftsman	100
Stenographer	75
Assistant engineers (four at $125)	500
Rodmen (four at $50)	200
Tapemen (four at $50)	200
Axemen (four at $40)	160
Teams (four at $100)	400
Tie inspector	100
Total	$2,210

Eighteen calendar months at $2,210 equals $39,780.

Construction.—The construction period is fixed at 1½ years, and the line divided into four sections of 11¾ miles each. The organization of the engineering force with the attendant salaries is given in Table 2.

Special Designing for Bridges and Buildings.—The recognized fee for consulting engineers and architects for the special designing of bridges and buildings is 5 per cent of the cost of the work, and an allowance of this amount has been made for those structures requiring such services.

Equipment and Machinery.—None of the equipment or machinery was designed by the railway, but was purchased direct from the manufacturers, and the cost of engineering would be included in the purchase price. The company would, however, require the services of a competent mechanical engineer to lay out its machine shops and determine the requirements of the company. It is considered that the sum of $1,000 should be ample to cover such services.

Table 3 summarizes the items making up the figure for engineering.

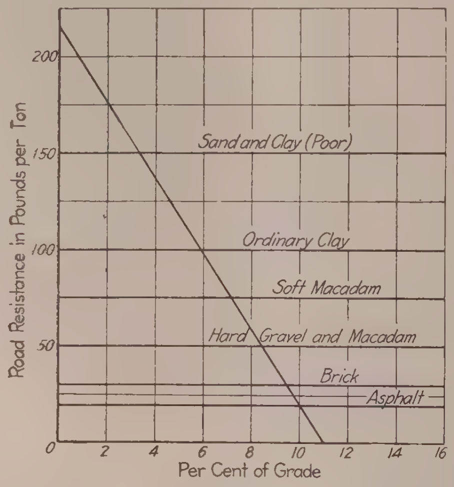
TABLE 3—SUMMARY OF ENGINEERING ITEMS

Reconnaissance	$1,000
Preliminary surveys	5,894
Final location	7,080
Camp equipment and instruments (less salvage)	500
Construction	39,780
Special designing for bridges and buildings	11,761
Equipment and machinery	1,000
Making of record maps and profiles	1,200
Total	$68,215
Cost per mile of road	$1,470

When Is It Feasible and Economical to Use Trailers with Motor Trucks?

Method, Evolved from Dynamometer Tests, of Matching Tractive Resistance with Tractive Force, Is Held to Prove Utility of Trailers

SEEKING to determine in a scientific manner when trailers are feasible and economical for use with motor trucks and when they are not, and then to translate this information, into non-technical processes that any maker or user of motor trucks can readily follow, G. R. Pennington of the Troy Wagon Works Company has recently conducted an extensive investigation of the subject. Dynamometer tests were made, first, with a standard motor truck to determine the basic tractive performance of that truck on a good level road, and, second, with the same truck, to determine a table of the relative resistance of different kinds of roads to standard trucks and trailers designed for use as such. A chart was prepared, based on two simple formulas, for translating the mechanical characteristics of any truck into tractive force. By means of the table and a simple formula for grade resistances the tractive resistance of any load is found. Comparison of force and resistance shows whether the truck can haul a trailer, or more than one trailer, under the given conditions. Mr. Pennington holds that the investigation shows conclusively that the trailer has a large field of usefulness, and that it in fact forms a strong argument for the motor truck in place of the horse.



MAXIMUM GRADES NEGOTIABLE ON VARIOUS TYPES OF ROAD WITH AVERAGE LOADED TRUCK AND EQUALLY LOADED TRAILER

PURPOSE OF DYNAMOMETER TESTS

The main purpose of the dynamometer tests was to determine the resistance offered by different kinds of roads to trucks and trailers. Preliminary to this, however, it was necessary to calibrate the motor truck itself by measuring its tractive force on a good level road. A 5-ton truck of standard make was used. It weighed 9100 lb. and carried a load of 10,300 lb., making a total weight of 19,400 lb.

The tractor truck was made to haul another truck similarly loaded, and a spring-scale dynamometer connected between the two recorded the drawbar pull exerted by the former. The first truck was run on each gear with wide-open throttle. The brakes on the second truck were then gradually applied, thereby exerting a backward pull on the first truck. The dynamometer readings recorded were of the maximum drawbar pull which could be maintained steadily. The averages of these were as follows: First gear, 3500 lb.; second, 1750; third, 1050 lb.

Correction had to be made, of course, for the slowing down of both trucks due to the braking. It was estimated that the speed was reduced from 10 miles to 5 miles per hour in a distance of 250 ft., which works out to be a negative acceleration of about 0.32 ft. per second. The force necessary to cause the acceleration would be the total load (19,400 lb.) times the acceleration (0.32) divided by the acceleration due to gravity (32.2). This works out to be about 200 lb., and each of the figures given in the foregoing paragraph should be diminished by that amount.

RESISTANCES

Of three main elements constituting the resistance, the wind resistance has been considered negligible, while that of the slight grade of the road on which the test was made was neutralized by the averaging of the figures recorded in both directions. The third element, that of the road resistance, was taken from the table derived from the second part of the test—25 lb. per ton for a road of that type, or 250 lb. for the truck. The net correction to drawbar pull, therefore, to obtain maximum tractive effort of the tractor was — 200 + 250 = 50 lb., and the tractive forces on the first, second and third gears respectively were 3550, 1800 and 1100 lb. From the foregoing it is seen that the tractive force of the truck reaches a maximum of about 35 per cent of its weight.

The second part of the test, to determine the resistance of roads of various classes to standard trucks and to trailers designed to meet the conditions, was made with a 5-ton truck and a loaded Troy trailer. The total weight of trailer and load was 16,250 lb., or about 8 tons. The trailer had rubber tires.

The dynamometer was connected to read the drawbar pull, and the trailer was towed over different kinds of roads. The results are shown in Table 1. For practical use Mr. Pennington has expanded this table into Table 2, embracing other types of road readily compared with those covered in the

TABLE 1—ROAD RESISTANCES OBTAINED FROM ACTUAL TESTS

Type of road	Drawbar pull	Road resistance lb. per ton
Smooth brick	240	30
Hard dirt	350	43
Sand 1 in. deep	760	93
Sand 1½ in. deep	1180	143
Sand 3 in. deep	2270	280

test and taking into account the variability of roads.

ANALYSIS OF TRACTIVE FORCE

Coming back to the tractive force, this is analyzed as follows: Let F = tractive force of truck in pounds; T, torque of motor in foot-pounds; R, total gear ratio; E, efficiency of truck; W, diameter of rear wheel in inches. Then

$$F = \frac{TRE}{W/2}$$

In the tractive-force test previously described T was known to be 225 ft.-lb., W was 40 in. and the various values of R were known. Consequently the transmission efficiencies could be figured, and were found to approximate 75 per cent in each case. In addition, however, there is another efficiency factor to be taken into account in the loss of power in the motor due to wear, carbon trouble and the like. This has been taken at 66 2/3 per cent, and the product of the two efficiencies becomes 50 per cent, or one-half. On this basis the factor of ½ in the foregoing equation cancels out, and we have, reducing W to feet for convenience, the empirical formula

$$F = 12\ TR/W$$

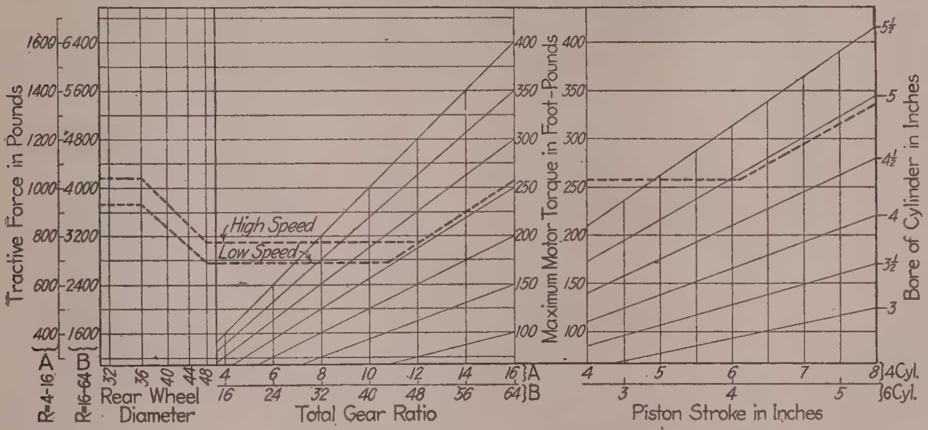


DIAGRAM FOR FINDING TRACTIVE FORCE OF MOTOR TRUCK, KNOWING ELEMENTS IN RIGHT-HAND AND BOTTOM SCALES

The accompanying large diagram for finding the tractive force of any standard motor truck has been prepared on the basis of this formula, and another empirical formula for the torque, $T = 0.55\ D$, where D is the total piston displacement in cubic inches, which is readily computed from the cylinder bore, the piston stroke and the number of cylinders. As to the derivation of this formula, the torque curves of the 3- and 5-ton motors of a standard make show that at 800 r.p.m. the motors develop torques of 130 and 225 ft.-lb. respectively. The motors have piston displacements of 226.52 and 361.56 cu. in. respectively. Adding the torques together and the piston displacements, the former sum is 60.36 per cent of the latter. To be conservative this figure is diminished to 55 per cent.

The three elements of piston displacement, then, together with the total gear ratio and the diameter of the rear wheel, are all that are needed to determine the tractive force of any standard truck; and all are known or easily found.

TABLE 2—ROAD RESISTANCES OF RUBBER-TIRED TRUCKS AND TRAILERS, AMPLIFIED FROM TABLE 1

Type of road	Resistance, lb. per ton
Asphalt or concrete	20
Smooth brick	25 to 35
Poor brick, ordinary cobbles or macadam	35 to 60
Hard dry clay or hard gravel	50
Soft macadam	75
Ordinary country clay road	100
Ordinary country sand road	150
Sand 3 in. deep	275 to 300

USE OF LARGE DIAGRAM

To use the diagram begin at the right end with the bore of the cylinder indicated on the vertical scale. Follow down along the oblique lines to a point directly above the piston stroke indicated by the horizontal scale corresponding to the number of cylinders. Carry this point horizontally to the left-hand torque scale, thence down along the oblique lines to a point vertically over the figure for total gear ratio on one of the horizontal scales at the bottom, thence horizontally to the left to the 48-in. line of the wheel-diameter scale, thence obliquely up to the vertical line indicating the rear-wheel diameter of the truck in question, thence horizontally to the left to the scales for tractive force, reading the A or the B scale, according as the gear ratio was above or below 16.

The dotted lines trace out the process for a four-cylinder 5-ton truck with 4 15/16-in. bore, 6⅛-in. stroke, total high-speed and low-speed gear ratios of 12:1 and 43:1 respectively, and rear wheels 36 in. in diameter. The high-speed tractive force, read from the A scale, is 1040 lb.; that on the low speed, read from the B scale, is 3730 lb.

The scales were fixed arbitrarily to accommodate the probable range of track characteristics as conveniently as possible. There is no significance, other than convenience, to the fact that the wheel-diameter and the cylinder-bore scales are not arithmetical. It is to be noted that the two A scales for tractive force must be used with the corresponding scales for gear ratio; also that if the piston stroke of the six-cylinder machine exceeds 5¼ in. the four-cylinder scale must be used and the torque multiplied by 1½, and vice versa, if the stroke of the four-cylinder machine is less than 4 in. the six-cylinder scale must be used and the torque divided by 1½.

WHAT LOAD WILL A TRUCK HAUL?

Now to determine what load a motor truck will haul on a certain road, and whether a trailer can be used, the process is as follows: From the large diagram the tractive force of the truck is obtained. Table 2 gives the road resistance per ton for the class of road under consideration. The grade resistance in pounds per ton is twenty times the per cent of grade. Ignoring wind resistance, the total resistance in pounds per ton is the sum of these two figures. If the tractive force divided by this unit resistance is more than the total contemplated weight of loaded truck and loaded trailer, the trailer can be used. If this quotient is considerably more than the total load, it may be found that two or more trailers can be used to advantage.

In applying the process it is pointed out that the maximum grade and the worst stretch of road must be used.

One further step in the study has resulted in the preparation of the small chart, in which grades and road conditions are equated. The diagonal line is the dead line determining whether or not a standard truck loaded to capacity can haul a Troy trailer equally loaded. If the intersection of grade and road condition comes above the line the trailer cannot be used; otherwise it can.

Summarizing the investigation, Mr. Pennington holds that it determines definitely and scientifically just to what extent Troy trailers can be used to advantage; that it shows that they have a large and definite field of usefulness; and that, instead of being a detriment to the motor truck, they give it a flexibility of use which should appeal to the truck manufacturers themselves.

Concrete Estimating Facilitated by Table

Weight per Foot and Volume of Concrete Beams Easily Obtained from Table Giving Cubic Feet per Linear Foot

TO SAVE TIME in designing and estimating concrete beam work, Henry A. Burr, assistant engineer, Nashville, Chattanooga & St. Louis Railway, Nashville, Tenn., has been using a table, reproduced herewith, which gives the volume in cubic feet per linear foot for rectangular beams of ordinary dimensions. For concrete weighing 150 lb. per cubic foot this table can easily be applied in obtaining the weight per foot for design purposes by simply adding half of itself to the given number and shifting the decimal point two places to the right. The total volume of the beam in cubic feet, of course, equals the value from the table multiplied by the length in feet.

CUBIC FEET IN ONE LINEAR FOOT OF BEAM

Depth,	Width in Inches							
In.	6	8	9	10	11	12	13	14
8	0.33	0.44	0.49	0.56	0.61	0.66	0.72	0.78
9	0.38	0.49	0.56	0.62	0.69	0.75	0.81	0.88
10	0.42	0.56	0.62	0.69	0.76	0.83	0.90	0.97
11	0.46	0.61	0.69	0.76	0.84	0.92	0.99	1.07
12	0.50	0.66	0.75	0.83	0.92	1.00	1.08	1.17
13	0.54	0.72	0.81	0.90	0.99	1.08	1.17	1.26
14	0.58	0.78	0.88	0.97	1.07	1.17	1.26	1.36
15	0.63	0.83	0.94	1.04	1.15	1.25	1.36	1.46
16	0.67	0.89	1.00	1.11	1.22	1.33	1.45	1.56
17	0.71	0.94	1.06	1.18	1.30	1.42	1.54	1.65
18	0.75	1.00	1.12	1.25	1.38	1.50	1.62	1.75
19	0.79	1.06	1.19	1.32	1.45	1.58	1.72	1.85
20	0.83	1.11	1.25	1.39	1.53	1.67	1.81	1.94
21	...	1.17	1.31	1.46	1.60	1.75	1.90	2.04
22	...	1.22	1.37	1.53	1.68	1.83	1.99	2.14
23	...	1.28	1.44	1.60	1.76	1.92	2.08	2.24
24	...	1.33	1.50	1.67	1.83	2.00	2.17	2.33
25	...	1.39	1.56	1.74	1.91	2.08	2.26	2.43
26	...	1.44	1.62	1.80	1.99	2.16	2.35	2.53
27	...	1.50	1.69	1.87	2.06	2.25	2.44	2.62
28	...	1.55	1.75	1.94	2.14	2.33	2.53	2.72
29	...	1.61	1.81	2.01	2.22	2.42	2.62	2.82
30	...	1.67	1.87	2.08	2.29	2.50	2.71	2.92
31	...	1.72	1.94	2.15	2.37	2.58	2.80	3.01
32	...	1.78	2.00	2.22	2.44	2.67	2.89	3.11

INVAR level rods to be furnished by an American company to the U. S. Coast and Geodetic Survey were to have been delivered this month, according to the U. S. *Commerce Reports*. War conditions have prevented the placing of orders abroad, whence the supply of invar has heretofore been obtained.

GERMAN TRENCH PROTECTED WITH STEEL PLATES ON TIMBER FRAMES

Photos. Press. Illust. Co.

TRENCH TRAVERSE (FOREGROUND) AND APERTURES FOR RIFLE FIRE

National Defense—For Engineer and Contractor

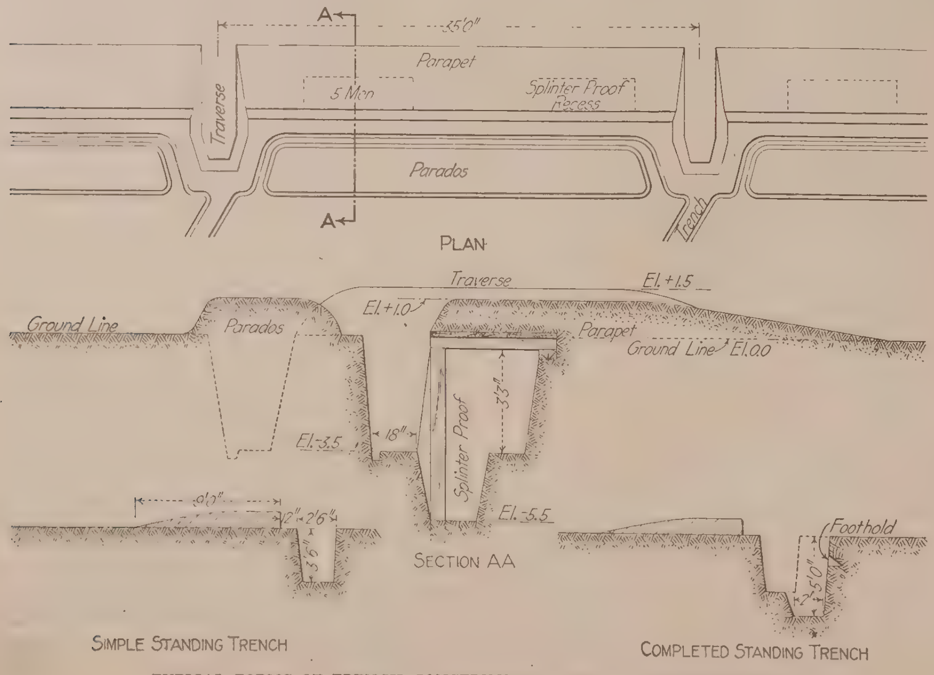
Fourth Article in Series Describing Tactical Considerations and Construction Methods Involved in Field Fortification—Selection of Position Important

By **MAJOR P. S. BOND**
Corps of Engineers, U. S. Army

FIELD FORTIFICATION is the most important and the most distinctively military of the many operations of the field engineer and constitutes an art and a science in itself. The art of fortification includes two branches, known as strategical or deliberate, and tactical or hasty fortification. Strategical fortifications include defensive works executed largely in time of peace for the protection of important harbors, cities, arsenals, etc. Tactical fortifications are those executed to meet the immediate tactical needs of the mobile army in the field, and are hence known also as field fortifications. The line of demarcation between the two classes is not clearly defined. Strategy and tactics are intimately connected, and so the works constructed to meet their needs vary from the elaborate coast defense works to the simple trenches of a rear guard fighting a delaying action.

The immediate purpose of field fortifications is to increase the power of resistance of the troops occupying them by decreasing their exposure to the fire of the enemy and increasing the accuracy and volume of their own fire. They thus serve to hold the enemy in check and limit his power of maneuver. Furthermore, they accomplish this result with the least number of men, thereby rendering the greatest possible number available for aggressive concentration of superior forces at the critical points.

Even in a successful attack the assailant cannot advance continuously. Halts will be necessary to permit of the bringing up of supplies and reinforcements, to refresh the troops, to hold the enemy in check, to select new points of attack, to readjust the artillery positions, etc. The assailant at all such halts must cling with the spade to that which he has won with the rifle and bayonet. Troops cannot remain stationary upon the field of battle exposed to the fire of the modern rifle, machine gun and artillery.



TYPICAL FORMS OF TRENCH CONSTRUCTION USED BY BRITISH TROOPS

Fortifications, therefore, while essentially defensive in their nature, will be extensively employed also in the attack. The neglect to utilize them will involve heavy losses and, if opposed to a skillful adversary, will invite defeat. On the other hand, their excessive and indiscriminate use limits the mobility of the troops and tends to destroy the aggressive spirit.

FIELD FORTIFICATIONS CLASSIFIED

The technical details of the works themselves are comparatively simple and readily comprehended, but their location, arrangement and adaptation to the tactical situation and to the terrain call for a high degree of skill, analogous to that required in road and railroad location. In general, fortifications are designed to serve two purposes: To facilitate the effective use of the weapons of the defenders; and to restrict the effective use of the weapons of the attackers. All constructions which serve either of these purposes may then be classed as field fortifications and will include the following:

(a) Rifle trenches for the firing line and cover trenches for supports. (b) Emplacements for machine guns and artillery. (c) Shelters for protection against fire, particularly shrapnel and high explosive shells, and against weather. (d) Communicating trenches between supports and firing line. (e) Observing stations, dressing stations, kitchens and latrines. (f) Obstacles to retard the enemy's advance and hold him under fire, including explosive mines. (g) Demolitions for clearing the field of fire and restricting the tactical maneuvers of the enemy. (h) Measures for concealing all works from the enemy's view. (i) Mining operations or tunneling for subterranean advance against the hostile works. (j) General communications, such as roads, foot paths, light railways, telegraph and telephone lines, signal stations, etc.

STANDING RIFLE TRENCH WITH SAND BAG AND HURDLE REVETMENT AND SPLINTER-PROOF SHELTERS UNDER PARAPET

Most of these works must necessarily be executed by the combatant troops who are to occupy them, and all line officers should be qualified to superintend their construction. The engineers, however, will constantly be called upon for advice and assistance as to location and details, and in the execution of some of the more difficult tasks their special training and equipment will be necessary.

SELECTION OF POSITION

The matters to be considered in selecting and organizing a position are: The mission or purpose of the command, their numbers and quality; strength, position and probable intentions of the enemy; the weapons possessed by both combatants; the nature of the terrain, facilities for maneuver or retreat; whether delaying or decisive action is contemplated; the time the position must be held; the time available for preparation, etc., etc.

The first requirement of a defensive position is that it shall be one which the enemy must attack to accomplish his mission. If he can attain his purpose without such attack, then the position is useless and the time spent in preparing is wasted.

The following are certain additional considerations to be given such weight as the particular circumstances of the case may require:

(a) Is it proper to take up a position, or does the situation call for advance or retreat?

(b) Is the position suited to the strength and armament of the force which is to occupy it?

(c) Is the position to be held indefinitely? If not, for how long a time?

(d) What are the strength and intentions of the enemy? What weapons has he? Is he provided with means for aerial reconnaissance?

(e) Are there good positions with a clear view and field of fire for both infantry and artillery? Is there a good field of fire at all ranges? If not, which is more important, a near or distant field of fire?

(f) What are the facilities for advance or retreat from the position?

(g) Are the flanks of the position naturally secure? If not, what expedients may be adopted to secure them?

(h) Are the communications within the position good?

(i) Is there cover for supports and reserves?

(j) Does the terrain present natural features adaptable to defense, or will great labor be required?

(k) Is the ground in front such as to facilitate the enemy's attack? Are there natural obstacles to his advance? Are any artificial obstacles required?

(l) Is the ground in rear favorable for counter-attack in case the enemy should penetrate the first line of works?

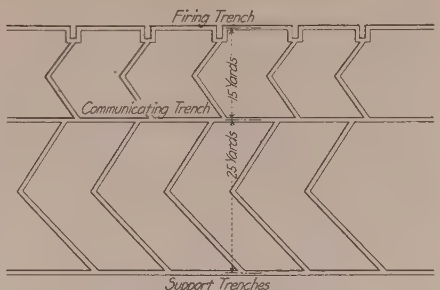
(m) Is the position naturally concealed from view, including view by aerial scouts? If not, what artificial means of concealment are possible?

These and many other important questions must be considered. A single position giving a favorable reply to all these questions will never be found. Any position must be a compromise between advantages and disadvantages.

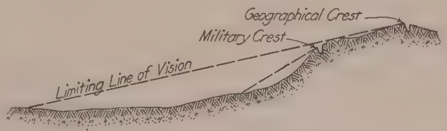
TRENCH CONSTRUCTION

Success in battle is determined by fire superiority, without which the assailant cannot advance and the defender cannot hold his ground. Field fortifications increase the fire effect of the troops occupying them and decrease the fire effect of the enemy. They are designed to afford the maximum protection and concealment while still permitting the unrestricted use of the defender's weapons. The shelter best fulfilling these requirements is the simple rifle trench, from which the soldier may deliver fire in a comfortable standing position over a low earth parapet or through a loophole in the parapet. Such rifle trenches are accordingly the principal feature of field fortifications.

The parapet is made sufficiently thick to resist penetration by rifle bullets or shrapnel, which requires about 3 ft. of ordinary earth. The parapet should be sufficiently high to afford a view of the foreground, but in order to be inconspicuous it should be no higher than necessary for this purpose. Ordinarily its height will be from 9 to 18 in. above the surface of the ground, unless excavation is very difficult, in which case a shallower trench and a higher parapet may be used. Such a trench affords no adequate protection against direct hits by high explosive shell, which would destroy the parapet and kill the man behind it. But the probability of such direct hits is very small and under battle conditions it has been found that the destruction of trenches by shell fire requires an expenditure of ammunition out of proportion to the results obtained. It is, therefore, seldom attempted. The attack of such trenches will be by means of showers of shrapnel and rifle bullets. While the actual physical effect of such fire in killed and wounded may not be great, it may force the defenders to keep their heads down below the parapet and prevent reinforcements from coming up, and this will diminish the volume and accuracy of their fire and permit the attacking infantry to advance against the trenches.



STANDARD FIELD TRENCHES



LOCATE TRENCH AT MILITARY CREST

TRENCH PLAN, SHOWING ZIGZAG LINES OF COMMUNICATION

HEAD COVER

To further decrease the vulnerability of the defenders the parapet may be provided with head cover by placing in the parapet loopholes of plank, sand bags, etc. This allows the occupants to deliver fire without exposing their heads and shoulders above

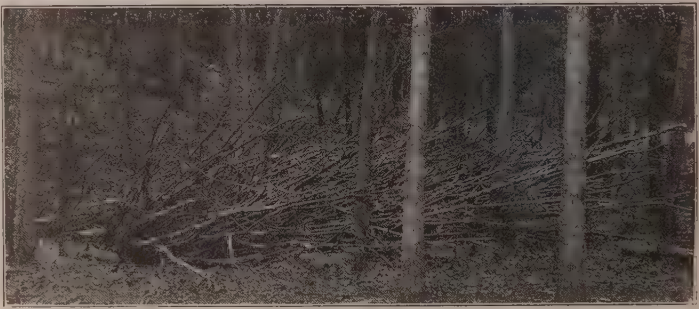
Photo. Underwood & Underwood

IN MODERN TRENCH CONSTRUCTION DAMAGE FROM AN ENFILADING, OR FLANK, FIRE MUST BE PREVENTED BY A ZIGZAG ALIGNMENT OR TRAVERSES WHICH BREAK THE CONTINUITY OF THE DEFENSIVE WORKS—VERY FEW PICTURES FROM EUROPE HAVE SHOWN THESE IMPORTANT FEATURES the crest of the parapet. Overhead cover, consisting of a shelf of plank covered with earth may also be provided. As this requires considerable time and labor to construct and greatly increases the visibility of the parapet as a target it is of limited application. The troops in the present European war are often provided with steel helmets stout enough to deflect rifle bullets and shrapnel fragments.

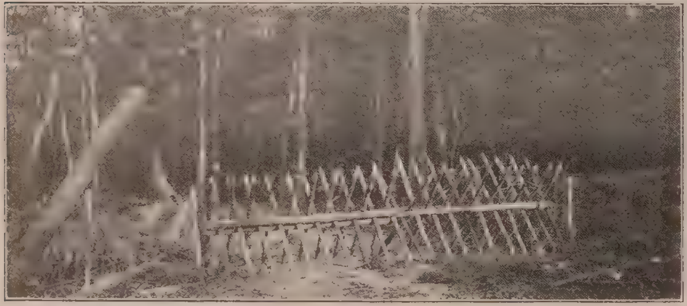
TRENCH REVETMENTS

The trenches are made very narrow with steep side slopes in order to reduce the possibility of shrapnel falling in the trench. If the earth will not stand naturally on a steep slope, some form of revetment must be provided. The most common forms are plank or hurdles of woven brush, sand bags, fascines, and the like. Drainage must also be provided if the trenches are to be occupied during rainy weather. If the trench can be properly graded a continuous drain may be carried along the back of the trench and led out at the lower end. Otherwise, sump holes may be provided at intervals. Surface drains may also be dug on the high ground above the trenches. To permit the movement of men along the trench it may be widened and deepened at the rear, or a separate trench parallel to and immediately in rear of the fire trench may be provided.

In order to protect the occupants from oblique or enfilade fire and to localize the effect of shells bursting in the trench, banks of earth perpendicular to the parapet and of equal or somewhat greater height may be placed at intervals. These are called traverses. They should be thick enough to resist penetration by rifle bullets and, in order to take up as little room as possible, their sides should be steep, and revetted if necessary. They are placed usually at intervals of one or two squads (8 to 16 men) and communicating trenches are dug around them, either in front or in rear.



→ ABATIS OR MILITARY OBSTACLE OF BRUSHWOOD



← CHEVAUX - DE - FRISE AND WIRE ENTANGLEMENT

Bomb proof shelters are often provided in the fire trenches for the supports or for sheltering the occupants when not actually firing. These consist generally of excavations under the parapet, open to the rear. If provided with a sufficient overhead covering of earth they afford complete protection except from grenades or shells bursting in the trench. They are provided with a roof of poles or planking. The roof may be placed on the ground and the earth excavated from beneath and thrown on top. A seat should be placed at the front and the headroom should be at least sufficient for a comfortable sitting posture.

CONSTRUCTION OF REDOUT

CONCEALMENT VITAL

Concealment from the enemy's view, both before and during combat, is a most important element of protection from hostile fire. The freshly turned earth of a parapet is exceedingly conspicuous, forms an excellent target unless concealed, and considerable labor and skill may well be employed to render the works inconspicuous. The trenches should be kept off the sky line. If necessary to place them on a crest they may be concealed by shrubbery or brush placed behind them. The first requirement for concealment is that the works should be blended with the existing natural and artificial features of the terrain. The parapets should be low and all sharp angles, either vertical or horizontal, should be avoided. If built on the turf this may be cut in strips, rolled to the front and rolled back over the parapet when the latter is completed, thus concealing the fresh earth. The parapet may be covered with leaves or shrubs naturally disposed and its ends should be graded gently into the natural ground. The parapet should be sufficiently high, however, to conceal the rear lip of the trench. Loopholes in particular are conspicuous and should be concealed by a shrub or branch, which will ordinarily not interfere with fire through the hole. A low, thin hedge will completely conceal a trench immediately behind it without interfering with fire. Works placed just inside the edge of a wood are very difficult to distinguish, but if the edge of the wood be sharply defined it will itself afford excellent ranging points for the hostile fire. Diversified ground, ravines and ridges, standing crops, scattered trees, hedges, fences, etc., lend themselves to the concealment of the works and should be utilized to the utmost. Skill in this particular branch of landscape gardening will produce remarkable results and, under favorable conditions, trenches may be rendered indistinguishable even at a distance of 100 ft. If opportunity is afforded, the works should be examined from the front, the enemy's point of view, when the necessity for concealment and the measures that should be adopted will become apparent.

SAND BAGS MAY BE USED FOR MACHINE OR FIELD GUN BATTERIES

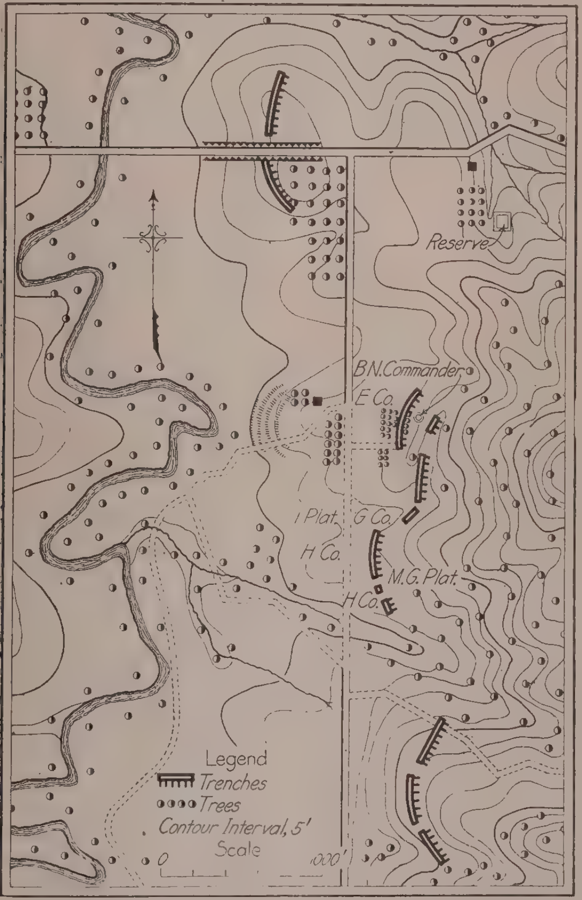
VALUE OF NATURAL COVER

The supports for the firing line should be placed as close to the latter as the requirements for easy concealment and protection from the enemy's fire will allow. Natural cover, if available within a reasonable distance, is to be preferred, because of both superior concealment and the lesser amount of labor required in its adaptation. Natural shelter also possesses the great advantage that it does not ordinarily restrict the tactical mobility of the troops to the same extent as cramped and confined artificial shelters, difficult of ingress and egress. Accordingly, while the immediate supports of the firing line must often of necessity be immobilized in artificial shelters, for the mobile reserves who must be ready for prompt concentration at the critical points, natural shelter well in rear of the firing line will almost invariably be sought. A covering ridge just back of a firing line may afford excellent natural cover, or may be artificially prepared with little labor, but in the absence of some such natural feature, artificial cover must be provided. This will usually consist of trenches in rear of the firing line. As such trenches are not required to deliver fire, more complete protection to the occupants is possible than in the fire trenches. The trenches are usually made very deep and comparatively narrow and may be roofed over or have bomb proof chambers leading out from them. In a position which is occupied for some time these chambers may be developed into elaborate subterranean barracks, with planked cealings supported by columns, drainage, water supply, artificial light and heat, etc. In this manner hasty field fortifications are gradually developed into elaborate siege works.

Communicating trenches must ordinarily be provided to allow of a safe passage between the support shelters and the firing line. As these trenches will be occupied only for a few seconds while passing to and fro, simple concealment from view will often be sufficient. The trenches, however, should usually approach the firing line in a direction oblique to the enemy's fire, that they may not be subject to enfilade, or they may zigzag to the front. The parapet is placed on the exposed side. If the location of these trenches is such as to render them conspicuous and subject to fire, they may be roofed over (cut and cover) or a subterranean gallery or tunnel may be substituted for an open trench.

ATTACK BY TUNNELING

Subterranean attack has long been characteristic of siege operations and may also be an important feature of modern trench warfare. It is conducted by sinking shafts and driving subterranean galleries towards the enemy's works. At the end of the tunnel a large charge of explosive is set off, destroying a section of the enemy's line of intrenchments. In the confusion following the explosion an assault overground is made on the hostile works. Protection against this mode of warfare is had by means of "listening galleries," driven forward from the intrenchments. By means of these the enemy's subterranean operations may be detected and measures taken to frustrate them. The excavation is made by hand with specially constructed tools, by the use of light charges of explosives or by boring machines operated by electricity or compressed air. Small trams may be used to remove the excavated material, and in long galleries artificial light and ventilation will be required. The galleries are lined with wood sheathing as the excavation progresses.



HOW TRENCHES ARE LOCATED TO COVER GROUND IN FRONT WITH THEIR RIFLE FIRE

KEY TO SKETCH

There are shown the trenches of three battalions, with the detailed dispositions of the center battalion. Small circles indicate trees. The enemy is approaching from the west, and it will be observed that the fire trenches in a general way occupy the convex faces of knolls or noses, with their flanks curved back or "refused" to sweep the ravines intersecting the front. The support trenches of the center battalion are also indicated—they are close in rear of the fire trenches. The trees, buildings and other obstructions which interfere with fire are demolished. In particular the loop of the creek which protrudes into the foreground in the center of the position is an element of weakness, because this creek with the trees on its bank affords a covered or concealed approach for the enemy. Accordingly the trees around this loop are thinned out (it is not necessary to cut them all) and the débris is thrown into the bed of the stream to obstruct it and prevent its use by the enemy. An examination of this may well indicate that these trenches are carefully disposed to cover with their fire all of the ground in their immediate front. Thus it will be observed that the fire trenches of E Co. of the center battalion cannot cover with their fire the very steep (hachured) slope in their front, immediately opposite the point of the loop in the creek. But this ground is effectively covered by the machine gun platoon (M. G. Plat.), by part of H Co., and by the fire of the southernmost trench of the next battalion to the north. Similarly it will be observed that the trenches of the center and left (southernmost) battalions are disposed to sweep the ravine between their positions, after it has been opened up somewhat by thinning out the trees and underbrush. The trenches of the northernmost (right) battalion enfilade or sweep the two branches of the creek in the foreground of the battalion's position. Here the trees should be trinned out to make the fire effective.

If opportunity allows, the foreground of the works will be prepared with a view to improving the field of fire and embarrassing the movements of the enemy. Trees, buildings and other features which obstruct fire are removed, roads and bridges demolished, ranges to important points measured, etc. In this work explosives are liberally employed to save time and labor. Fire should be used sparingly, as it renders the locality conspicuous both during and after the conflagration.

MILITARY OBSTACLES

Obstacles of various kinds are placed in the foreground to retard the enemy's movements and hold him under the fire of the defense. Ravines which might permit concealed approach may be choked by felling trees in them. Low land may be inundated by means of dams in the streams.

All obstacles should be such as to retard movement without affording cover from fire. The most effective obstacle is a belt of wire, preferably of barbed wire, strung on posts. This is known as a wire entanglement and is difficult to remove or destroy by explosives. It may be effectively concealed in high grass or standing crops. It should usually be placed close in front of the trenches in order to prevent its removal by the enemy and to hold him at the point where the defender's fire is most effective.

Other favorite forms of obstacles are abatis or slashings of trees with barbed wire interlaced, palisades or picket fences, pits covered with brush, wire fences, chevaux-de-frise, military explosive mines with charges of broken stone, and the like. As with the trenches, great pains should be taken to conceal these obstacles from the enemy's view.

As the best protection against hostile fire is concealment from view, night attacks are of common occurrence in trench warfare, and to guard against these, artificial illumination of the battlefield by night is essential. This is accomplished by means of flares, screened toward the rear, and searchlights. The searchlights are often placed on the line of the fire trenches, but generally will occupy some commanding point, such as a ridge or hillock in rear of the line. Arrangements should be made for moving them occasionally from place to place, as if fixed in one position they are liable to be reached by hostile fire.

Machine guns are employed in the fire trenches or in specially prepared emplacements in the intervals. They are extensively used to support the line at localities where infantry fire is restricted. Artillery is usually placed behind the line of infantry defense, natural cover being utilized as far as possible.

The numerous and infinitely various works included under the term "field fortifications" will usually be executed under the most trying conditions. Frequently they must be constructed actually under hostile fire. The details of the works are therefore necessarily simple, but this very simplicity is the highest expression of the skill of the designer, as there is a very great tendency to over-elaboration. It is to be borne in mind that the works must ordinarily be constructed by the troops which are to occupy them and that of the average untrained man little more than ordinary earth excavation can be demanded. The works, therefore, must be designed for rapid construction by unskilled labor with simple tools and the materials of nature. These conditions and the experience derived from meeting them have resulted in the development of certain type plans. These plans are by no means rigid but must be infinitely varied to meet the actual conditions, such as terrain, nature of soil, tools and materials, time available for construction, etc. Each situation is unprecedented and calls for new measures adapted to the circumstances. The engineer or line officer who directs the work must have a thorough knowledge derived from study and experience of the demands of the situation, the works that will be required, the relative importance of the different works, and the time that will be required to construct them. Without a comprehensive grasp of the situation the works will be poorly located and badly adapted to the situation, and confusion instead of system will characterize the operations. In the end, unnecessary bloodshed and loss of life, defeat and ruin of the combatant force, or national disaster will be the logical results of incompetence and inexperience. Hasty fortification is one of the highest of the fine arts whose practice demands in a superlative degree judgment, skill and experience, and in whose field the novice and incompetent may cause utter disaster and ruin.

[*The next installment of Major Bond's articles will deal with military road building and maintenance.*—EDITOR.]

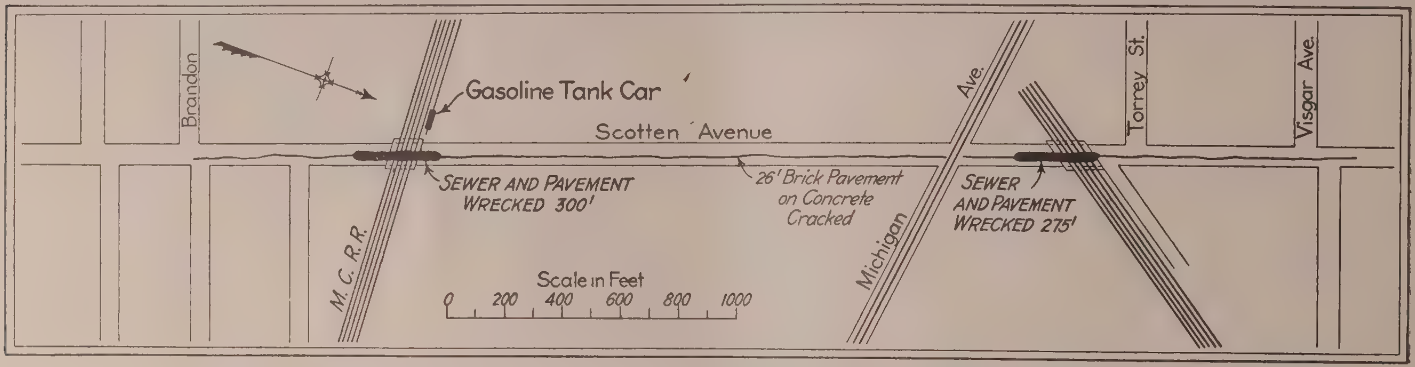
STREET PAVING TO COST APPROXIMATELY $250,000 will be done at Ontario, Cal., during 1916, according to recent reports. On the completion of this work the city will have nearly 20 miles of concrete asphaltum pavement, built at a total cost of about $500,000, and connecting with all state and county highways now built or in the course of construction.

Leaking Gasoline Caused Detroit Sewer Explosion

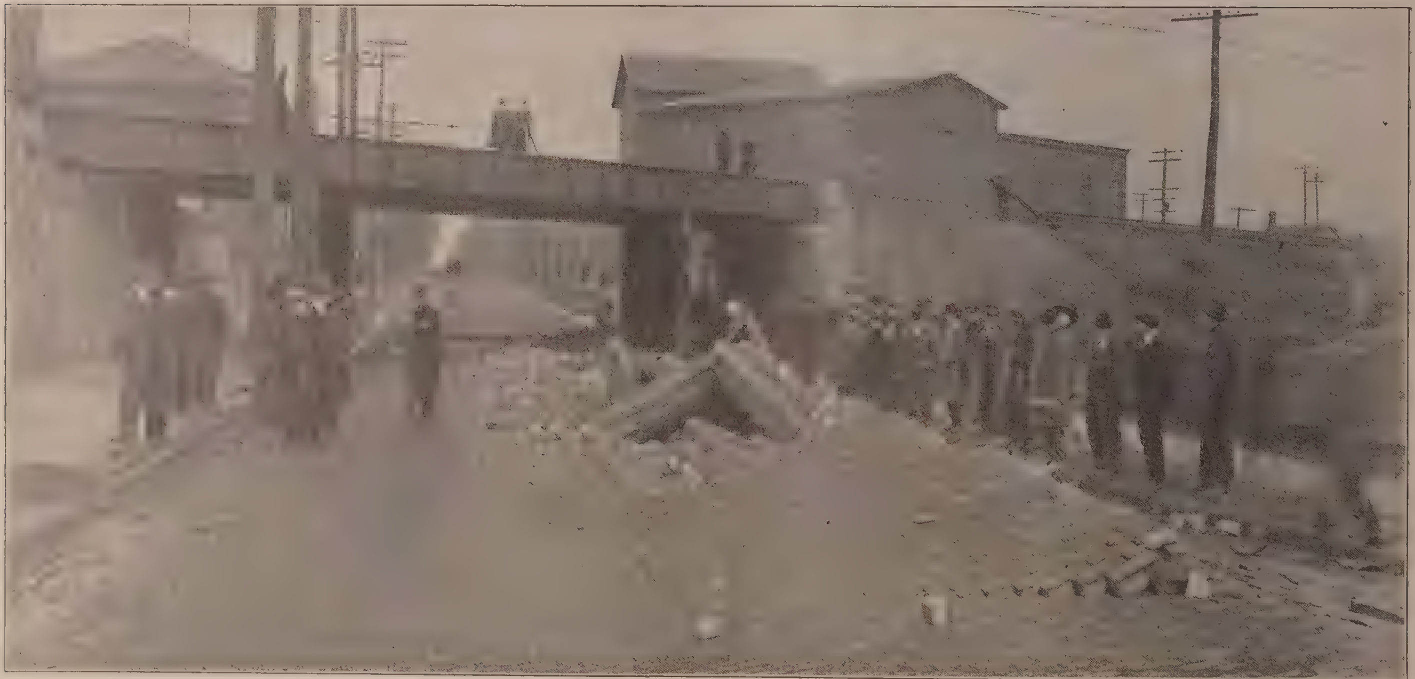
Valve on Tank Car Cracked by Freezing Water —Sewer Burst and Brick Pavement Cracked

By A. L. SEARS
Assistant Sewerage Engineer, Detroit, Mich.

GASOLINE from a leaking oil tank car on a railroad siding near Scotten Avenue, Detroit, entered a nearby sewer and exploded with terrific force on March 12, heaving up and cracking several blocks of brick pavement, and blowing heavy manhole covers 200 ft. from their seats.



WHERE THE TROUBLE STARTED—LOCATION OF LEAKING TANK CAR ON RAILROAD SIDING



BRICK PAVEMENT AT DETROIT WAS HEAVED UP AND CRACKED FOR DISTANCE OF 4000 FEET BY GASOLINE EXPLOSION

The gasoline leakage was noticed 8 hr. before the explosion. The manager of the oil company arrived on the ground 3 hr. later and found it impossible to stop the leak. About 600 gal. were salvaged from the car of 10,000 gal. capacity.

TANK OUTLET FROZEN

The leak was probably caused by water freezing in the cast-iron cap of the outlet which fractured the cap and distorted the valve inside. In bursting the cap allowed the gasoline to run from the car onto the ground, over the concrete retaining wall, entering the sewer via the catch basin. Whether the liquid vaporized under pressure of confinement in the sewer, or some smoker caused the explosion, is not known.

LOCATION OF DAMAGE

The sewer is about 16 ft. deep, except at the two subways. The greatest damage was done south of Michigan Avenue at the Michigan Central Railroad subway. The sewer at this point is a 5-ft. 2-in. cylinder, two-ring brick, with invert 8 ft. below the top of the pavement; it was built in 1888. The sewer and brick pavement for 300 ft. at this point were entirely destroyed. The bricks adhering to the 6-in. concrete foundation were blasted into various size pieces, some weighing 2 or 3 tons. The ground was frozen to a depth of 18 in. and came up with the pavement.

The same condition occurred at the Michigan Central Railroad subway north of Michigan Avenue. The sewer here is a 4-ft. 6-in. cylinder, two-ring brick. The pavement was torn up for a distance of 275 ft. The pavement here is brick and for a distance of 4000 ft. crevices show at the surface; in some places these fissures would indicate that the arch of the sewer may have been partially destroyed. An inspection of the interior of the sewer had not been made when these notes were prepared, but it is very probable that 500 ft. will have to be rebuilt south of Michigan Avenue, not shown on the sketch.

Manholes along the line of the sewer for 1¾ miles were damaged and the covers weighing 145 lb. were blown 200 ft. or more. Windows were broken and considerable damage to property was caused. The detonation was heard for miles. An investigation was begun immediately after the accident occurred.

Tile Used for Coal Bunkers Instead of Steel or Concrete

THE coal bunkers of the Conners Creek power station, Detroit, Mich., according to J. N. Hatch, consulting engineer, Chicago, in a paper presented recently to the Western Society of Engineers, are steel plates lined with thin tile, laid in bitumastic cement. A number of Eastern power stations have concrete bunkers with steel-beam ribs. Mr. Hatch stated that the main objection to cement bunkers is their great weight, which makes the supporting structure expensive. Further, the concrete becomes pitted and rough so that the coal does not slide well. Unlined steel-plate bunkers are the lightest and would be the most satisfactory, in Mr. Hatch's opinion, if it were not for the rusting, which requires replacement in 10 or 12 years. Steel plates lined with thin lining have not, however, been in service long enough to fully demonstrate their economy.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

What Causes Peculiar Refraction on Arizona Desert?

Sir: The only condition seriously regarded as materially affecting the accuracy of stadia measurements is the unequal refraction resulting in the light rays from the top and bottom targets when the line of sight from the instrument to the rod lies close to the ground. The momentary passing of mist or disturbance from heat waves, while both affecting stadia work, are so apparent as to force themselves on the attention of the instrumentman, and he, therefore, needs no forewarning against them. The first mentioned fact is also so well known that the careful field man uses the stadia under those conditions with due precaution. The following phenomena, though, is of a type different from the refraction and heat difficulties mentioned.

In the month of December, 1915, in running lines over exceptionally rough country, where measurements with steel tape would have been slow and difficult, the writer attempted to use stadia. The conditions, both as to nature of country and atmosphere, were apparently ideal for good results. The work was located in western Arizona, in the Hualpai Mountains, on the Arizona desert. A section four miles square failing to close by something like 150 ft., the lines were rerun, using both stadia and steel tape, the same shots being repeated. The result was that while the chaining checked closely the stadia work showed a marked variation from the former readings. The instrument used was a standard Young & Sons' transit, with a very good erecting telescope, with fixed stadia wires. It has given good results all summer in other states, and a careful examination disclosed nothing wrong.

The use of stadia was then discontinued, but the writer conducted a protracted series of experiments, ending in the conclusion that, owing to some obscure characteristic of the atmosphere on the Arizona desert, the lines of sight from the top and bottom targets on a rod even sighting across deep canyons, are so unequally and erratically refracted, that only the roughest approximations to correct distances may be secured by the use of stadia. In a single series of observations, extending over about a half hour in time, an idea may be conveyed as to the behavior when it is stated that, although rod and transit were separated by a deep ravine, some thirty chains wide, each being as near as possible to the edge, the variation in the rod intercept was as great as 0.5 ft. This apparent motion seemed to be confined to the lower target, which, with the top wire of the reticule bisecting the top target, could be observed to rise or sink above or below the lower wire to the extent noted. This motion was not of the nature of a vibration, and was, in fact, so slow as to be inappreciable without the aid of the horizontal wire as a guide. The temperature was about 50 deg. Fahr. and there were no heat waves, mist, or other disturbing atmospheric condition perceptible to any of the senses.

Since the time mentioned, the writer has taken this pehnomenon up with numerous members of the field force, but has heard of only one similar incident. Charles M. Pidgeon, U. S. Surveyor, reports an almost identical experience, under similar conditions, which led him to entirely abandon the use of stadia in Arizona.

It is to be hoped that, if others have at any time observed such a condition, and can explain it, or offer a method of procedure by which the stadia may still be used with good results where such conditions obtain, a statement may be drawn from them.

THOMAS A. HAYDEN,
Surveyor General's Office.
Phoenix, Ariz.

Writing Land Descriptions

Sir: I have noted with interest and much satisfaction, the recent communications relating to the work of the land surveyor, and desire to express my appreciation that it is not considered beneath the dignity of an engineering journal to devote some space to this less scientific subject.

It is now over 30 years since the writer ran his first retracing of land bounds, and the varied experience gained in this work, largely in New England, has impressed him with the importance of accurate field work and intelligent description of bounds.

Here in the Eastern states, the irregular lines of the parcels of land as described by the colonial surveyors, presented no easy task to the one who years later attempted to re-locate the bounds. Many of the ancient deeds, which were our only evidence to follow, offered "northerly" or "easterly" for direction, and so many "rods more or less" for length of lines. The corners as mentioned were trees or stakes, long since obliterated by time. The older residents of the vicinity when appealed to as a last hope, would each give a different opinion. Small wonder that in many instances the undisputed possession for a term of years, was the only legal loophole for a title.

Occasionally, a deed bearing the date of the eighteenth century, would be offered that was a marvel of accurate delineation, giving in degrees and minutes the bearings, and in chains and lengths the distance. Right here, however, was liable to follow one of the more serious errors. Some later surveyor, armed, perhaps, with a "blacksmith's compass," as described by a correspondent in your issue of March 4, may have attempted to retrace the lines using the original deed for a description. Without knowledge of calculating the magnetic declination, he located the bounds by following the bearing of the original description. A new land deed, bearing this later date, is used by another surveyor sometime afterwards. He may be a competent man, allowing for the variations of the compass, but only for the years since the date of the evidence given him, assuming that his predecessor did the same. We can readily see how one incompetent surveyor may vitiate land titles, although preceded and followed by competent men.

Sometimes I have thought that our technical graduates rather scorned the duties of a surveyor of land. The lure of larger and more spectacular achievements in the strictly engineering field was more attractive. And yet, the title to land is at the base of all wealth, and no better schooling may be found than a year or so devoted to country surveying, where the bounds of small parcels of land are to be retraced from the original delineations. I hope that the standard this work deserves will receive proper recognition.

F. H. CARPENTER.
Providence, R. I.

Shall the American Society of Civil Engineers Move Its Headquarters?

Sir: I have your letter asking for my opinion on the proposal that the American Society of Civil Engineers join with the other national engineering bodies in the use of the Engineering Societies' Building. I have given this matter very careful consideration and favor the plan for the following reasons:

1. There is a marked tendency among the engineering societies to work along parallel rather than divergent lines. There is also need of concerted action by the different engineering societies on many questions of professional as well as general public interest, such as the licensing of engineers, the recognition of the engineering profession in the statutes and the organic law of the different states, the mobilization of the engineering resources of the country for the purpose of more effective national defense, etc.

2. The inclusiveness of the American Society of Civil Engineers, which was the first national professional engineering society to be established in this country. There are undoubtedly more members of this society who are also members of one or more of the other national societies than is the case with respect to these other societies, and, if it is desirable that the headquarters of the national societies should be closely in touch with each other and should be located under the same roof, this would appear to be more important in the case of the American Society of Civil Engineers than in that of any of the others. The Civil Engineers are undoubtedly somewhat isolated in their present location, while the other national societies are located in a single building nearly a mile away.

3. The location of the Engineering Societies' Building and the Engineers' Club contiguous to each other on Thirty-ninth and Fortieth Streets, between the two great railway terminal stations on Manhattan Island, has made this locality the engineering center of the city and of the country, and the influence of the national engineering societies having their headquarters in this engineering center would probably be greater than would be the case were the different societies located in different parts of the city. The Civil Engineers have that disadvantage, while the other national societies have whatever advantage there may be from their location in the center of engineering activity.

4. The location of all of the national societies in one building offers an opportunity for the creation of a great engineering reference library which would undoubtedly be the greatest technical library in the world. The report of the Board of Direction of the American Society of Civil En-

gineers strongly intimates that substantial gifts toward the creation and maintenance of such a great library are likely to be made, and this likelihood would undoubtedly be increased if all the engineering societies were grouped together in one building.

The above considerations have prompted me to vote in favor of the acceptance of the proposal which has been made by the United Engineering Society.

Nelson P. Lewis.

New York City.

Sir: In reply to your letter it gives me pleasure to say that I have favored the American Society of Civil Engineers joining the other three national societies in the Engineering Societies' Building on West Thirty-ninth Street ever since the project was first broached, provided it could secure suitable accommodations for its administrative operations and for the library, at the same time preserving its autonomy. In my judgment the opportunity which would thus be afforded for cordial co-operation and association among the four great national professional engineering organizations would be highly advantageous to each and all of them in every way. The present proposition, as described and announced to the members of the American Society of Civil Engineers, especially that plan which contemplates adding two and one-half stories to the present Engineering Societies' Building for its accommodation, seems to me to meet the requirements of the situation in a highly satisfactory manner, and I trust the vote will be favorable to its adoption.

Wm. H. Burr.

New York City.

Sir: Taking advantage of your generous offer to open your columns to the discussion of this subject, the undersigned wishes to express some views which are somewhat at variance with your own, as expressed in your editorial of Feb. 5, 1916.

Unless I am very much mistaken, one of the important reasons why the American Society of Civil Engineers did not join with the other engineering societies in the project financed by Mr. Carnegie in 1903, was that the American Society of Civil Engineers wished to be independent of Mr. Carnegie's aid. That situation is still unchanged.

In the editorial referred to, you state that this move would remove the physical barrier between the societies. Bearing in mind the fact that a very large proportion of the members of the several societies seldom comes to New York, and that to them the society's headquarters is merely the place from which their *Proceedings* are mailed, and remembering further that the meetings of the various societies would necessarily be held on different nights, so that the members of the different societies would not come in contact at all, just what physical barrier would this step remove?

I cannot conceive of any business which the secretaries of the different societies would have which would not be transacted by letter, or which could not be done by phone; at any rate, the time required to pass from Thirty-ninth Street to the Fifty-seventh Street building is very short.

Occupants of different suites in the same office building see little more of each other than occupants of different buildings, nor can I conceive that the business of joint committees would be facilitated by housing under one roof.

You say that the housing under one roof would declare to the country at large that all engineers were standing together, etc. Would it? The fact that we are now housed under two roofs does not by any means indicate that we are not in accord, nor would the converse be true. Furthermore, who outside of our own members would know that we were under the same roof, or care? Our public statements and actions are far more important than the address from which our literature is distributed.

It is often said that it is folly for the American Society of Civil Engineers to maintain an entire building and two large halls which are vacant most of the time and that for that reason alone we should move to the Thirty-ninth Street building, but since it would cost us the same amount, why move?

It is important to remember that if occasion for a special meeting arises, our halls are always available, as the military lectures now going on bear witness to. If we move to the Thirty-ninth Street building, this will no longer be true.

Your statement that the Fifty-seventh Street neighborhood is on the decline for the purpose of such a society house puzzles me greatly. The place is very accessible, eminently respectable, well kept and quiet, and to me seems far preferable to Thirty-ninth Street. What is there that is objectionable?

On the evening of the first military lecture, Feb. 14, 1916, about 700 engineers were turned away from the Thirty-ninth Street building by the New York Fire Department because the building was dangerously overcrowded. Some of those turned away were members of the American Society of Mechanical Engineers, coming to attend to business of their own, and who were not interested in the military lecture at all. Some of these men came from out of town, but were not permitted to enter the building. This is a condition which I would not like to see arise in the building occupied by the American Society of Civil Engineers.

True, this was an unusual condition, but it will be much more likely to occur in that building with still another and larger society housed there than heretofore.

In the building occupied by the American Society of Civil Engineers the auditorium, library and reading room are all on the same floor and with large doors between, affording very convenient places to read and visit before the regular meetings. After the meetings the members go downstairs to the smoking room on the main floor where the collation is served and where they gather to talk and walk about. It will be well to remember that in the Thirty-ninth Street building, these conveniences do not exist; the lunch is passed around among the seats after the lecture, and things are exceedingly cramped and uncomfortable. The lecture hall on the fifth floor which would be used for these meetings is low ceilinged, poorly ventilated and with the amount of smoking that goes on at the Fifty-seventh Street meetings would be almost intolerable. Our present lecture hall has a very high ceiling with ample ventilators.

One of the most enjoyable meetings of the American Society of Civil Engineers is the annual smoker, which is now held at the society house. This affair is attended by many out of town members and is the only opportunity which many members have of seeing the society's home. There is no place in the Thirty-ninth Street building where the smoker could be held, and it would have to be held in a hired hall, as is the annual reception. For me, this would remove much of the pleasure of the occasion.

I feel convinced that the Thirty-ninth Street building with the changes proposed would fall far short of being as satisfactory to the American Society of Civil Engineers as its present home on Fifty-seventh Street now, to say nothing of the additions which we might make there in the future.

Though I have talked with many who are opposed to this proposed move, I have not yet seen their views in print, and for the benefit of such members of the society who live at a distance from New York and whose opinions are necessarily influenced by what they read in influential technical papers, I urge that these views be thoroughly aired.

Frank C. Boes,
Assoc. M. Am. Soc. C. E.

West New Brighton, N. Y.

Sir: The five arguments in your editorial "What is the New Evidence?" (Feb. 19, 1916, page 239), might have been extended to include mention of one reason for the negative vote in the American Society of Civil Engineers thirteen years ago. At that time the society was in fairly comfortable quarters, paying its own way and with a comparatively small bond issue or mortgage outstanding. As a business organization the society was maintaining relations exactly like those which it is the prime object of engineers to promote and secure in any of the engineering or business affairs intrusted to them by clients. Under these conditions many members were opposed to the acceptance of a sum out of all proportion to the small increments previously given by many members and of which all were justly proud because of the extended interest shown. The fact was understood and appreciated that the proposed donor had manifested ability of the highest order in selecting and creating avenues by which assistance reached those who were seriously in need. There is a difference between loss of a feeling of independence and loss of "dignity" and, further, there is a difference between standards "high" and "low" in the estimation of the public where charity is sought or given.

For a number of years yet the present quarters of the American Society of Civil Engineers should be reasonably ample and satisfactory. If it later develops that a location in or about Thirty-ninth and Fortieth Streets should be a center for many societies the society could procure a site, erect a larger building and be in close and friendly relations as now with all neighbors. Under this plan they would not overcrowd a structure that soon will be filled to more than two extra stories by the natural growth of the original planting. The civil engineers would thus maintain for themselves the same sense of independence that has been prized and respected in the past.

H. F. Dunham.

New York City.

Road Construction by the Massachusetts Highway Commission during 1915 was finished on 63 miles of state routes. The total length of state highways is now 1101 miles. About $3,000,000 has been spent in the last three years.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

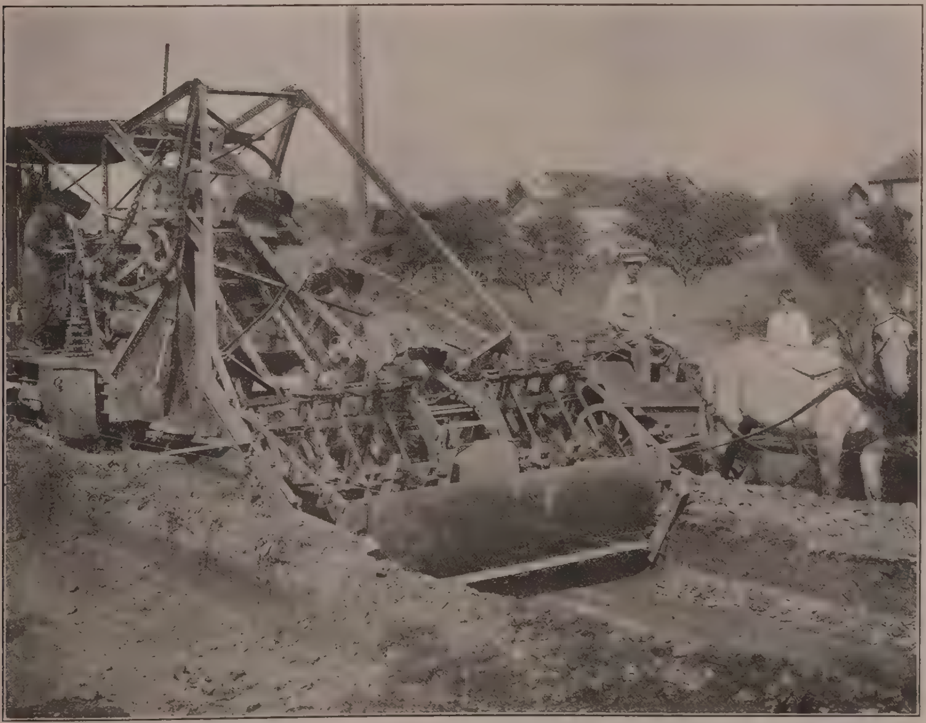
Contractor's Excavator Attachment Makes Shallow Street Cuts

FOR making shallow cuts in streets where space is limited and the material must be hauled away from the site, a contractor of Rockford, Ill., has devised the outfit shown herewith as an attachment to an ordinary Austin trench machine with 24-in. buckets. It consists of a revolving cutter frame or wheel 5 ft. 10 in. in diameter, rotated by the bucket chain, which travels on a sprocket on the shaft of the cutter frame. Behind this wheel is a "crumber" or scraper plate. The cutter consists of six rows of eight rooters. There are also pitched transfer plates to carry the earth loosened by the rooters toward the bucket line, which in turn elevates it in the usual way to the cross conveyor delivering to the wagons.

The machine cuts a strip 8½ ft. wide and from 2 in. to 5½ ft. deep. The cutting wheels operate on a boom which can be raised or lowered by screw. An indicator is provided so that the operator can run true to a grade line. It is claimed that the rate of loading is so uniform that the number of teams can be properly proportioned each day to the length of haul so that there will be very little team time lost at the machine each day.

In practice it is found best first to make the outside cuts on street work, cutting to a line to allow room for the curb and gutter and the forms. On the outside cuts the excavator is pitched to conform to the crown of the street. If the width of the street slightly exceeds three cuts a center cut is made sufficiently deep so that the surplus at each side can be leveled and rolled into the central space. It is found desirable to cut slightly below the finished subgrade and at the last cut to finish the fine grade at once by dumping sufficient material from the wagons to level it up to the desired grade. The street is then rolled at once, and in this way less work is required than for making a fine grade by removing the surface material with hand tools. Material at alley intersections is cared for by excavating deeper in front of the intersection for 16 to 24 ft. on each side. The intersection is then plowed and slip scrapers used to transfer the earth into the extra cut.

MACHINE CUTS TO EVEN GRADE


CONTRACTOR DESIGNED EXCAVATOR ATTACHMENT TO ELIMINATE HAND WORK ON STREET CUTS

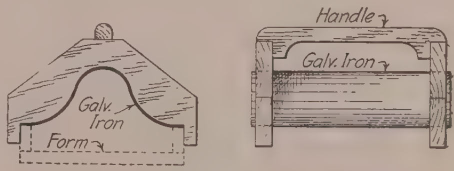
In street railway track excavation the track trench is usually 18 to 20 in. deep and 8½ ft. wide. The cut is made in one excavation. By removing the track closely ahead of the machine and by laying new track directly behind it, cars can be kept running with a break and transfer of not more than 150 or 200 ft. About 500 ft. of track trench can usually be handled in a 10-hr. day.

These machines were built and have been operated during the seasons of 1914 and 1915 in Illinois by the General Engineering & Construction Company, of Rockford, Ill.

Finishing Tool Saves Forms Work on Bridge Handrail

By R. C. HARDMAN
Colorado Springs, Col.

USING the finishing tool illustrated herewith, the writer constructed a short time ago an unusual concrete handrail without the use of forms other than a shallow supporting trough. The handrail had a length of about 1400 ft. and was in forty-one short sections between posts. The unusual cross-section, which did not readily adapt itself to the use of a form, was intended to prevent the ubiquitous small boy from walking on the rail to his probable injury. The shallow trough form was built around the cast concrete balusters and the reinforcement put in place. The finishing and shaping tool, fashioned to the section of the rail, was made of wood and galvanized iron. In building the rail the trough was filled with a fairly dry mixture heaped up in the center. The tool, which had projections to engage the form and to act as guides, was then used to roughly form the heaped-up concrete to the required shape. Additional dry concrete was added as required until the full section was built up. A wetter and richer mixture was then placed for surfacing, and finished smoothly by the same tool. The ends of the iron were flared upward slightly to secure better work.



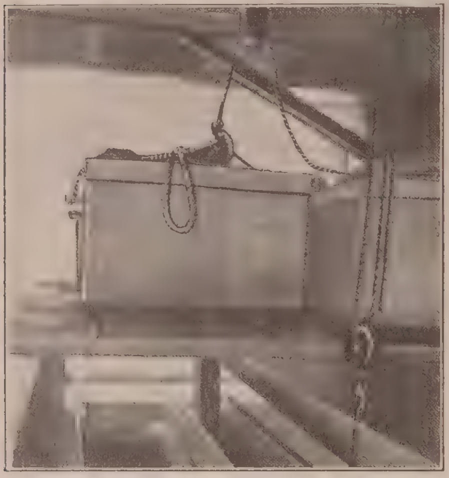
TOOL SAVES FORM FOR HANDRAIL

Expansion joints were provided for the rail at intervals where similar joints were located in the bridge. These were made at the posts by inserting in the posts short sections of gas pipe of the required size to receive the rail reinforcement. The reinforcing rods fit the pipe snugly enough to allow free movement without danger of concrete entering and bonding the reinforcement to the pipe. A sheet of asphalt cut to the section of the rail was then fitted around the reinforcement and formed the joint between the rail and post.

The finish produced by this tool was free from the waves usually apparent in work of this sort. This was due both to the guides on the tool and to the exercise of care on the part of the workman.

Two Loops in Rope Save Time in Snubbing Buckets Down Incline

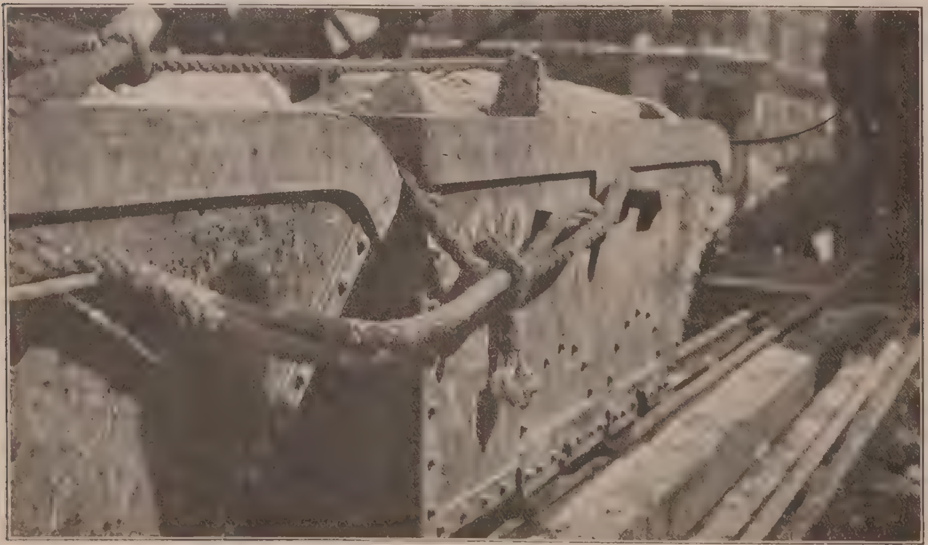
A LOOP spliced in each end of a 50-ft. length of manila rope, the bight of which is given a turn around a wood ship cleat, is saving time in snubbing wheeled skips down alternate sides of a double-track bridge to the deck of a motor truck at the shaft changing platforms on section 3 of routes 4 and 36 of the new Broadway subway in New York City. The shaft plants on this section, which were described on page 152 of the Engineering Record for Jan. 29, 1916, are a new departure, and consequently are being steadily improved. When it was found the loaded shiks were too light to be checked effectively by the brake, acting from below, a manila line in the end of which a loop was spliced was used to hold them. This had to be overhauled each time and rearranged on the cleat. By putting loops on both ends of the line it is now made to overhaul itself, and when a skip has descended on one track, the loop on the other end of the line is in place to throw over the next skip on the opposite track of the changing platform. As the second skip goes down, the travel of the line around the cleat is merely reversed.



WITH LOOP ON EACH END LINE DOES NOT HAVE TO BE OVERHAULED BY HAND

The time of loading the trucks has been further cut materially by sending down two or three loaded skips on each side in a train, so that the snub line, attached to the leading skip, is overhauled only once for each track to load one truck. The skips are coupled together with short lengths of manila rope, having eyes in each end to slip over the trunnions of the buckets. The rigging is well shown in the accompanying photographs.

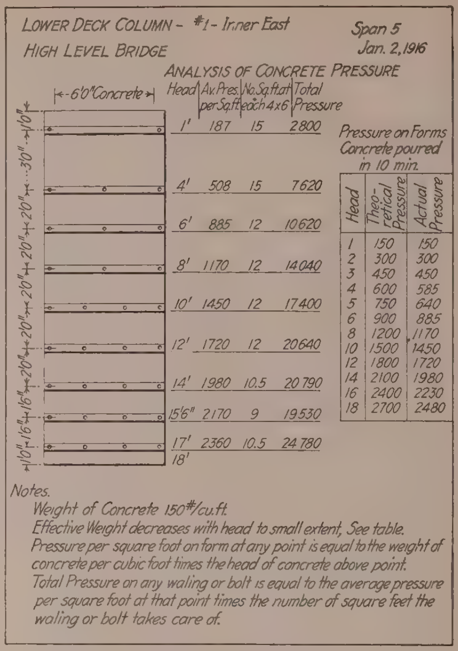
This section of the Broadway subway is being constructed by the Holbrook, Cabot & Rollins Corporation, under the direction of George Hallett Clark, for the Public Service Commission for the first district of New York State.



BUCKETS TIED TOGETHER WITH SHORT LENGTHS OF LINE COME DOWN INCLINE IN TRAIN

Night School Helps Contractor's Foremen and Job

The Hunkin-Conkey Construction Company is making an organized effort at Cleveland to train their foremen in the simple branches of engineering and scientific methods of doing construction work. Many companies in other lines of work make a regular practice of training their men to work by standards and scientific methods, but in construction work there is usually too much rush to think of anything but field methods for educating foremen. In order to give the men a uniform training, increase their interest in their work and fit them for more responsible positions the foremen on the Detroit-Superior high-level bridge, eleven in all, are called together one evening a week in the drafting room of the head office of the company. Each man is provided with a drafting board, instruments and a handbook. Lessons are presented, on blueprints of uniform size, in mechanical drawing, mechanics of materials, graphic statics, hydraulics as applied to concrete pressure, concrete form design and scientific management of construction work. All illustrations are based on the work on the high-level bridge and the fifteen other jobs now under construction by the company. By associating each problem with some definite piece of work familiar to all, even men with no technical education readily grasp the principles involved. Harold E. Ketchum, superintendent of the bridge, is conducting the class.



LOWER DECK COLUMN - #1 - Inner East
HIGH LEVEL BRIDGE
Span 5
Jan. 2, 1916

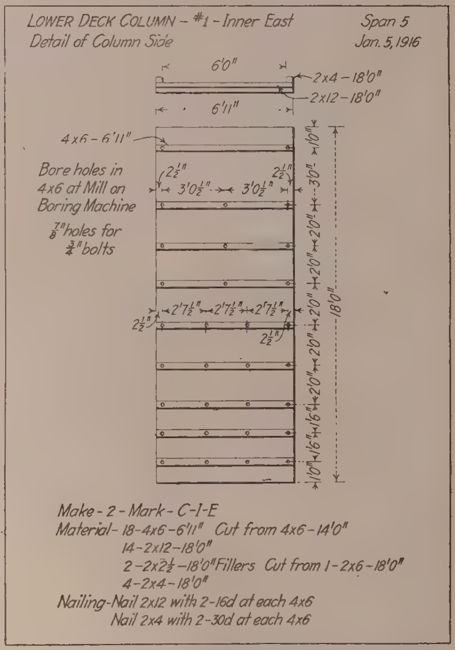
ANALYSIS OF CONCRETE PRESSURE

Head	Av. Pres. per Sq. ft.	No. Sq. ft. at each 4x6	Total Pressure
1'	187	15	2800
4'	508	15	7620
6'	885	12	10620
8'	1170	12	14040
10'	1450	12	17400
12'	1720	12	20640
14'	1980	10.5	20790
15'6"	2170	9	19530
17'	2360	10.5	24780
18'			

Pressure on Forms
Concrete poured in 10 min.

Head	Theoretical Pressure	Actual Pressure
1	150	150
2	300	300
3	450	450
4	600	585
5	750	640
6	900	885
8	1200	1170
10	1500	1450
12	1800	1720
14	2100	1980
16	2400	2230
18	2700	2480

Notes.
Weight of Concrete 150#/cu.ft.
Effective Weight decreases with head to small extent, See table.
Pressure per square foot on form at any point is equal to the weight of concrete per cubic foot times the head of concrete above point.
Total Pressure on any waling or bolt is equal to the average pressure per square foot at that point times the number of square feet the waling or bolt takes care of.



LOWER DECK COLUMN – #1 - Inner East
Detail of Column Side
Span 5
Jan. 5, 1916

Make - 2 - Mark - C-1-E
Material - 18-4x6-6'11" Cut from 4x6-14'0"
14-2x12-18'0"
2-2x2½-18'0" Fillers Cut from 1-2x6-18'0"
4-2x4-18'0"
Nailing - Nail 2x12 with 2-16d at each 4x6
Nail 2x4 with 2-30d at each 4x6

BLUEPRINTS LIKE THESE HELP CONTRACTOR'S FOREMEN GRASP CONSTRUCTION PROBLEMS

THE NUMBER OF LICENSED ENGINEERS and architects in Illinois is given in a paper by W. C. Armstrong, of St. Paul, Minn. Since the enactment of the architects license law in Illinois in 1897 there have been granted, up to Jan. 31, 1915, 1124 licenses, and at that time 917 architects in the state held licenses. Since the structural engineers license law went into effect July 5, 1915 (see the Engineering Record of July 17, 1915, pages 63 and 71), 1169 applications for licenses have been made, of which number 613 have been acted upon favorably and the balance, 556, are pending investigation, with the probability that few will be rejected.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Railway Engineering Association Elects Officers

Fifteen-Foot Side Clearance Agreed Upon at Early Sessions—Committee Proposed 16 Ft. and Many Wanted to Retain 14 Ft.

A three-hour discussion of clearances was the outstanding feature of the first two days of the Seventeenth Annual Convention of the American Railway Engineering Association in Chicago this week. The 16-ft. total side clearance proposed by the Committee on Rules and Organization was opposed by many who wished to retain the 14-ft. now in the *Manual*. A compromise of 15 ft. was finally reached. In general the discussion was lighter than in other years, although the attendance was up to standard, with 494 members and many guests registered at the end of the second day. A full account of the discussions will appear in next week's issue. In his presidential address Robert Trimble, chief engineer maintenance-of-way, Pennsylvania Lines, Northwest System, reviewed briefly the year's work of the Association and the important railroad developments. He pointed out the difficulty of the railroads of planning for the future in the face of the uncertainties of the war, Federal valuation and state and federal legislation. The Society now has 1336 members, a net gain for the year of 100. The surplus on hand is not quite $14,000, a decrease of $3,400, owing to slow collections. The officers elected for the coming year are: President, A. S. Baldwin, chief engineer of the Illinois Central Railroad; vice-president, C. A. Morse, chief engineer of the Rock Island Lines; treasurer, George H. Bremner, assistant district engineer, Interstate Commerce Commission, Chicago; secretary, E. H. Fritch; directors, R. N. Begien, C. E. Lindsay and W. D. Pence; members of the nominating committee, A. M. Burt, A. F. Robinson, E. B. Temple, M. A. Long and W. K. Hatt.

American Waterworks Fixes Date for New York Convention

Members of the American Waterworks Association were notified this week that the thirty-sixth annual convention will be held at the Hotel Astor, New York City, June 5 to 9. The facilities for the exhibits of equipment are said to be on a grand scale and the Waterworks Manufacturers' Association promises a display far superior to that of any previous convention. Visits to points of engineering interest are being arranged as one of the convention features and an excellent program of papers is said to be assured.

A. S. Baldwin New Head of Railway Engineering Association

A. S. Baldwin, chief engineer of the Illinois Central and the Yazoo & Mississippi Valley Railroads, and first vice-president of the American Railway Association, was elected president of that organization at the annual convention in Chicago this week.

Mr. Baldwin was born at Winchester, Va., in 1861. He was educated in private schools, and after teaching school one year, entered railroad service. His first railroad employment, in 1880, was as rodman for the Richmond & Alleghany Railroad, now the Chesapeake & Ohio. The next year found him with the Iron & Steel Works Association of Virginia, engaged on railroad and blast-furnace construction, and the development of ore mines. Here, as assistant engineer and engineer, he remained for three years.

From 1884 to 1886 he was in the employ of the Baltimore & Ohio Railroad on the construction of its Philadelphia extension. He then went to the Chicago, Milwaukee & St. Paul Railway as principal assistant engineer on the construction of its bridge across the Missouri River at Kansas City. Following this, after a short period on the construction of what is now the Louisville, Henderson & St. Louis Railway, he entered the service of the Louisville & Nashville Railroad, where he remained from 1887 to 1901, serving successively as assistant engineer, assistant to chief engineer, and roadmaster. In the fall of the latter year he came to the Illinois Central as principal assistant engineer. In May, 1903, he was made engineer of construction, and in March, 1905, was appointed to the office he new holds, that of chief engineer.

Elected to Presidency of American Railway Association This Week

A. S. BALDWIN

Hearings to Be Held on New York City Building Restrictions

The dates for hearings on the tentative plans for building restrictions proposed by the commission on building districts appointed by the Board of Estimate of New York City have been set for the different boroughs as follows: Manhattan, March 27, 28, 29, and 30; Brooklyn, April 4, 10, 11 and 17; Bronx, April 3 and 5; Queens, April 6, 13 and 18; Richmond, April 12. In all cases the hearings will be held at 10.30 a. m. in the rooms of the Board of Estimate at the City Hall. The general principles upon which this districting of New York City has been based, and some of the proposed heights and use limitations will be found in the Engineering Record of Feb. 26, page 248.

To Start Work on $5,500,000 Waterworks and Sewerage Contract in Uruguay

Ad Referendum Contract Signed Last Year by Ulen Contracting Company of Chicago Ratified by Uruguayan Senate

The ad referendum contract, entered into Nov. 12, 1915, by the Ulen Contracting Company of Chicago and the Uruguayan Government, for waterworks and sewerage systems to a value of $5,500,000 in various cities of the republic has ben ratified by the Senate of that country and executed by the President. The contractor will start work as soon as possible. Some engineers and other members of the construction force have already been sent to Uruguay. Thomas S. Shepperd, vice-president of the A. Gillespie Company, who will be general manager for the Ulen Company in Uruguay, will sail with other members of the force April 1st.

Preliminary Work Took a Year

The negotiations preliminary to signing the contract consumed about a year. They were handled by John R. Ulen, vice-president of the company and E. G. Trueheart, the chief engineer.

Wherever possible native engineers and construction superintendents will be employed, and all the unskilled labor will be obtained in Uruguay. The part of the force to be obtained in the United States has already been employed or arranged for. All materials likewise have been provided for.

The contract is believed to be one of the largest ever entered into by a contractor native to the United States for municipal improvements outside of this country. A $6,500,000 bond issue was authorized for the construction of the Havana, Cuba, waterworks contract which was executed by the Runkle-Smith Company, an American concern of which R. A. C. Smith, the present commissioner of Wharves, Docks & Ferries of New York City, was a principal and $16,000,000 was provided for the Havana sewerage and paving contract, which is now almost completed, but only the first of these can fairly be classed as pioneering in a foreign field. The sewering and paving project was planned, and the contract for it entered into under the direction of authorities appointed by the United States Government.

The main office of the Ulen Contracting Company is in the First National Bank Building, Chicago. The Uruguayan office will be located in Montevideo. Henry C. Ulen is president of the company.

Lehigh Valley Considers Immense Freight Terminal

The building of an immense new freight terminal at Jersey City, N. J., for the Lehigh Valley Railroad at a probable expenditure of $5,000,000 depends on the willingness of the Jersey City officials to grant the Lehigh Valley the privilege of making various changes in the present arrangement of the streets and sewers in the area selected as the site for the new structures, and to take care of certain tax matters on the property under consideration.

Options for the desired 400 acres of land having about ½ mile of water frontage on the Jersey shore off Ellis Island are in the hands of the Lehigh officials but further than this, nothing will be done until the desired rights are granted to the railroad by the Jersey City Commissioners.

Although definite plans have not yet been made, it is understood that the new terminal will be designed to accommodate a large number of big ships as well as a heavy schedule of railroad freight. It is also suggested that there will be a connection with the new pier near Ellis Island, where heavy freight and ore from South America might be unloaded.

The proposed freight terminal will not interfere with the passenger service, which would be continued from the station of the Central Railroad of New Jersey.

Strike on Alaska Government Railroad Ended March 7

The strike of men employed on the construction of the government's Alaska railroad ended March 7, when the Federal Labor Union at Anchorage, Alaska, voted to return to work pending a settlement of the wage controversy. Four hundred men resumed work and more will be put on as soon as the union formulates a wage scale which will be fixed by a committee representing the union and the Alaska Engineering Commission. The strike began Feb. 7 when sixty tracklayers working on the Anchorage-Matanuska branch demand an increase in pay from 37½ to 50 cents an hour.

$100,000 Bonds Voted for Klamath, Oregon, Drainage

The members of Klamath district, Klamath Falls, Ore., recently voted authority to bond the district for $100,000 in order to begin the work of reclamation of the 27,500 acres of marsh land in Klamath county. The directors of this district are said to have the support of other land owners, and will issue the bonds as needed in order that work can be started without delay. The county court will be petitioned to appoint viewers to ascertain what lands will be most benefited by the bond issue. It is reported that plans are under way to perfect arrangements with the Southern Pacific Railway for connecting the district's dykes with the railway embankment near the lower lake, which arrangement would result in saving the cost of an additional dyke.

Extension Road-Building Course

The University of Oklahoma, Norman, Okla., under the auspices of the director of the school of civil engineering, James I. Tucker, has prepared a correspondence course in highway work. The complete set of twenty-four lessons is now available and about thirty have enrolled in the course. Thus far 125 lessons have been sent in, with every evidence of interest and enthusiasm.

Interest in the course is rather widespread, correspondence being now under way with highway engineers, departments and colleges in Massachusetts, Kentucky, Wisconsin and Texas.

The major part of the course is devoted to the fundamentals, such as road economics, road administration, drainage, etc. There are chapters on the types of roads particularly adapted to conditions in the Southwest—earth, gravel, stone, sand-clay and oil-mixed roads.

To Change Oregon Bridge Laws

The contractors of the State of Oregon are reported to be working to repeal the amendment to the law passed by the Legislature last year, which permits counties to construct bridges under their own supervision when the bids submitted are considered too high. Previously, all such work had to be let by contract.

Consider Macadam Highway Across the Isthmus of Panama

A macadam highway across the Isthmus of Panama is contemplated for the near future according to the February *Bulletin* of the Pan American Union. A survey for the road which will be 75 miles in length, stretching from Boquete to the Atlantic seaport of Rovola, has just been completed by J. T. Luttrell, an American engineer. It will pass through virgin country and will cross a mountain range at an altitude of 6000 ft.

Cuba May Nationalize Railways

President Menocal of Cuba signed a decree, Feb. 10, appointing a commission to prepare and submit a report, within the next six months, on a plan for the nationalization of the railways of the island. According to the *Bulletin* of the Pan American Union, the decree sets forth that the railways by raising freight rates have injured the agricultural interests of the country, that they are unable to handle the volume of traffic offered them and that the management has entered into numerous controversies with patrons of the lines. The commission will consist of the Secretary of the Interior, the Secretary of Justice, the Secretary of Finance, the assistant Secretary of State, a civil engineer, a banker, a financier and two railway experts.

Kansas City Engineers Meet

The program for the Institute for City Engineers held at the University of Kansas, March 14 to 18, contained many interesting addresses. The city engineers and other public officials were put in touch with new developments in engineering and the reliability and durability of various materials was shown by actual tests.

Papers were read on: "City Planning," "Reinforced-Concrete," "Water Purification," "Manufacturing as a Factor in City Development," "Water Softening," "Recent Development in Brick Pavements," "Asphaltic-Concrete Pavements," "Brick Rattling Test and Road Materials Test," "Concrete Road Building," "Sewage Disposal," and "Testing of Water Meters." Many of the talks were illustrated by motion pictures and proved of more than ordinary interest.

Arizona to File on Power Sites

Attorney General Wiley E. Jones has requested Senators Ashurst and Smith and Congressman Hayden of Arizona to introduce legislation in Congress which, it is hoped, will result in Arizona being granted permission to file on power sites on navigable rivers in that State, particularly along the Colorado River in the Grand Canyon.

New Asphalt Boulevard Planned for San Francisco

Plans for the new Hunters Point Boulevard, to extend from Railroad Avenue and Evans Street to the Hunters Point drydock, are being made in the office of M. M. O'Shaughnessy, city engineer of San Francisco. The boulevard will be 80 ft. wide and paved with asphalt on a 6-in. concrete base for its entire length. The maximum grade will not exceed 4 per cent. This is one of a series of projects, which, it is reported, the city engineer has outlined for the coming year to develop the industrial possibilities of the lower San Francisco district.

Iowa State Drainage Association Elects New Officers

The recent meeting of the Iowa State Drainage Association is said to have been one of the most successful ever held and it is believed that those in attendance fairly represented all phases of the agricultural interests in the United States. Representatives attended from Minnesota, Illinois, Missouri, Michigan and Washington, D. C., and the success of the 1916 meeting is credited to H. M. Sparboe, the retiring president, who had held office for five years. The officers elected for the ensuing year are: President, J. W. Boyer, Fort Dodge; vice-president, John T. Drug, Stratford; secretary, F. P. Costelloe, Ames, Iowa.

Engineers Call Upon Congress for Real Preparedness Measures

Pass Resolution at Military Lecture in New York—Captain Coiner Describes Selection of Camp Sites and Water Sterilization

Calling upon Congress to expedite its deliberations on the army and navy programs, the members of the New York military lecture course, representing the four national engineering societies, passed by a unanimous vote Monday night a resolution demanding from senators and representatives at Washington, legislation based on the opinion of experts, which will insure adequate national defense. Copies of the resolution are to be sent out broadcast so as to leave no doubt in the minds of congressmen as to the exact sentiment of the engineering profession on the subject of military preparedness.

After the vote had been taken, Captain Richard T. Coiner, Corps of Engineers, U. S. A., explained the methods of selecting and laying out camp sites, sterilizing drinking water and providing facilities for the disposal of refuse. Camp sites, he said, should be located on high, well drained ground, although ideal locations are rarely found in practice. An abundant supply of pure water is a camp necessity, and where the purity of the water is in doubt some means of sterilization must be employed. Heat is the army's most reliable water purification agent.

In one of the devices the incoming raw water was jacketed around the hot sterilized water so that by an exchange of heat the effluent was cooled and the raw water heated, thus reducing to a minimum the necessary amount of fuel. Plain boiling of water in cans is practised when no sterilizing equipment is at hand, but Captain Coiner warned the men who expect to go to camp not to do any water sterilizing experiments on the company cook's stove. "Nothing makes a cook so peevish," Captain Coiner said, "as to have his range cluttered up with the men's mess kits."

Other forms of sterilization are chemical treatment in canvas bags and a simple type of portable mechanical filter using a coagulant.

Captain Coiner concluded his address by outlining the principle precautions to take in the disposal of camp refuse.

Preparedness Resolution Passed

The resolution passed at this week's meeting follows:

"Engineers assembled in public meeting on March 20, 1916, under the auspices of the Engineers Committee on Military Lectures, believe that it is unworthy a great nation like the United States and that it is dangerous to the peace, safety and liberty of its people, to remain in our present position of inadequate military, naval and industrial preparedness.

"We believe that between pacificism and militarism there is a just, safe and proper ground, greatly in advance of our present position—a ground which involves large additions to both the navy and army, a large increase in our schools for training officers and a coordination and mobilization of the physical and industrial resources of the nation.

"We believe that this nation should never make war except to enforce peace; that when strongly supported by armed resources its influence in maintaining its own liberties and rights, and the liberties and rights of the weak and oppressed throughout the Americas will be greatly strengthened.

"We believe that Congress should give due weight to the opinion of experts and should then appropriate sufficient money to put the nation in a position of defense against attack on either the Atlantic or Pacific Coast.

"We demand that our Representatives in Congress act in accordance with this expression."

Scientists Committee Suggests Remedies for Panama Slides

That navigation through the Panama Canal will not be seriously interrupted by slides after the present obstructions near Culebra have been removed is the conclusion reached in a preliminary report made public March 16 by the committee of scientists and engineers appointed by President Wilson to investigate conditions at the Isthmus.

The committee believes that every available and practicable device should be used to turn rain from ground that is sliding and prevent its entering adjacent ground, and it suggests the following measures:

1. Covering slopes with vegetation.—The committee believes that threatening ground bordering the slides, quiescent slides, and, so far as practicable active slides ,themselves should be sufficiently covered with vegetation to prevent surface wash.

2. Closing peripheral cracks.—Before extensive movements of the ground occur warning is frequently given by the appearance of cracks peripheral to the coming slide. As soon as they are formed they should be filled up in order that they may not intercept surface water.

Photo. Underwood & Underwood

COMMITTEE OF ENGINEERS AND SCIENTISTS DURING THEIR RECENT INSPECTION OF THE PANAMA CANAL

3. Drainage of undisturbed and threatened areas.—Undisturbed and threatened areas near the slides should be thoroughly drained both by surface and by tile drainage, to keep as much water out of them as possible, for they may become unstable and they may supply water to the slides. Experiments with tile drainage on a small scale would soon show whether it is effective enough to justify its extension.

4. Drainage of the great slides.—A complete system of open drains should be established on the great slides and the water carried away as directly as possible.

5. Drainage by tunnels.—Drainage by means of tunnels might be adapted to a few special cases, but should be tried with caution, and extended only in cases which promise results commensurate with the cost.

6. Sluicing.—It is suggested also that a cut be made by sluicing in the East Culebra slide, starting at an appropriate point on the canal and diverging from it diagonally in a general southeasterly direction, in the zone of gentle slopes and in such a position as to reach the large pond which now exists on the slide.

"In addition to the immediate remedial measures suggested above, there are certain observations and protective measures which should be undertaken with a view to the future. A few slides are now in motion, but many more are quiescent," the report adds.

The report was prepared by a committee consisting of Charles R. Van Hise, president of the University of Wisconsin, chairman; Gen. H. L. Abbott, Corps of Engineers, U. S. Army; John C. Branner, geologist, and former president of Stanford University; Whitman Cross, geologist in the U. S. Geological Survey; R. C. Carpenter, professor of mechanical engineering in Cornell University; Arthur P. Davis, chief of the Reclamation Service; John R. Freeman, consulting engineer, Providence; J. F. Hayford, dean of the College of Engineering, Northwestern University, and Harry Fielding Reid, professor of engineering, Johns Hopkins University.

U. S. Coast and Geodetic Survey to Hold Centennial Exercises

The Centennial Exercises of the U. S. Coast and Geodetic Survey will be held April 5 and 6 at Washington, D. C. The meeting scheduled for the afternoon of April 5, will be devoted to addresses on the bureau of fisheries and its relation to the U. S. Coast and Geodetic Survey, the work done by the Survey in the field of terrestial magnetism, its ocean currents and deep sea explorations and U. S. Geological Survey and its relation to the U. S. Coast and Geodetic Survey.

In the evening the program will be devoted to exploiting the part the Coast and Geodetic Survey has played in the development of commerce, and the relations between it and the Lighthouse Service. Brig.-Gen. W. M. Black, Corps. of Engineers, U. S. A., will talk on the relation of the U. S. Corps. of Engineers to the Coast and Geodetic Survey, and George W. Little will speak on the subject of hydrography and charts.

The afternoon of April 6 will be devoted to discussions of the contributions of the Coast Survey to geodesy and physical geography and the international work of the Survey will be discussed. President Wilson will speak at the banquet to be held on the evening of April 6 which will end the meeting.

Harrisburg Board of Public Works Is No More

The Harrisburg Board of Public Works, after directing the expenditure of $2,250,000 in public improvements, including a filtration plant costing $325,000; a sewage improvement costing $365,000; a dam across the Susquehanna, $82,000; a bridge over the Pennsylvania Railroad tracks, $366,000; and construction of a river wall and intercepting sewers, $333,000, has been abolished. All of the work is completed with the exception of a small amount on the river dam which will be finished this spring.

National Septic Process Protective League Formed

Will Defend All Suits Against Members for Excessive Royalties for Infringement of Cameron Septic-Tank Patents

The National Septic Process Protective League was formed at a meeting of the League of Iowa Municipalities, held in Des Moines, Iowa, March 14. Dr. H. M. Bracken, secretary of the Minnesota State Board of Health, was elected president and F. G. Pierce, of Marshalltown, Iowa, secretary-treasurer. The object of the league is to defend all suits filed against its members for the infringement of Cameron septic-tank patents. All municipalities, corporations, companies and individuals interested in sewage disposal are eligible to membership, subject to the approval of the executive committee.

Reason for Action

Quite recently a number of Iowa municipalities have been notified by the Cameron Septic Tank Company of patent infringement for the use of septic tanks, filters and other appurtenances of sewage disposal plants. It was to consider these claims for royalties on sewage disposal plants that the meeting was called.

Prof. A. Marston, Ames, Iowa, discussed the development of septic tanks and the litigation in regard to the claims for royalties. H. E. Sampson, assistant attorney general of Iowa, explained the legal status of the Cameron claims, especially in the light of the recent decision against the city of Winchester, Ky.

Following a general discussion a committee on organization brought in a resolution which stated that demands for excessive royalties on account of certain alleged patents were being made; that able attorneys advised that the patent has already expired; that the interests of the general public can best be protected by contesting the validity of the alleged patent, by ascertaining the scope of its claims and by refusing to pay royalties until after the courts of final juridiction have upheld validity of the patent and the liability for royalties.

Contributions

For raising funds it was recommended that assessments be based on population of municipalities graduated as follows: $10 for towns of less than 2000 people; $15 up to 5000; $20 up to 10,000; $25 up to 20,000; $30 up to 50,000 and $35 for more than 50,000 people.

The board of direction is made up of two representatives from each State and the executive committee will consist of the officers and four directors chosen by the board, C. A. Haskins, Paul Hansen and Lafayette Higgins of the Kansas, Illinois and Iowa State Boards of Health respectively, were chosen for the executive committee, with Prof. A. Marston, Iowa State College, as the fourth advisory member. The following directors were elected: For Iowa, Dr. J. F. Cole, president, League of Iowa Municipalities, and Lafayette Higgins; Kansas, C. A. Haskins; Ohio, W. H. Dittoe, engineer State Board of Health; Illinois, Langdon Pearse, assistant engineer, Sanitary District of Chicago, and Paul Hansen; California, W. J. Locke, secretary, League of California Municipalities, and Charles Gilman Hyde, consulting engineer, State Board of Health; Minnesota, H. A. Whittaker, State Board of Health, and G. A. Gsell, secretary Minnesota League of Municipalities. To fill vacancies and to represent states not sending delegates directors will be named and approved by the president and the secretary. About thirty-five deelgates from the four States noted were in attendance.

Letters from the Cameron Septic Tank Company were quoted from to the effect that the alleged infringements of the Cameron septic tank patents are not confined to what are frankly called "septic tanks," but extend "to those which employ putrefactive reduction of sewage solids, but which for purposes of evasion have been styled 'sedimentation' or 'settling tanks,' as well as to the more recently exploited 'Imhoff' or 'two-story' septic tank." The terms for licenses are based on the cost of the plant, upon the length of time it has been in operation, and are 3 per cent per annum on the original cost of the complete plant and subsequent additions, "including the tanks, contact beds, filters or other appurtenances, for the number of years each plant has been in operation to date of settlement, plus an additional 3 per cent for the remaining unexpired term of the patent."

Competition for Designs of Workmen's Houses

As announced briefly in the Engineering Record last week, the National Americanization Committee, through a sub-committee known as the Housing Competition Committee, will award prizes for the best designs for low-cost houses for immigrants. The object is to encourage the speedy adoption of American standards of living. As a first step in this direction the housing must be satisfactory. Since these buildings must rent at a very low price, economy of construction and maintenance are vital.

Full details as to the competition, which is open to engineers, architects and all interested in the subject, can be obtained by addressing the National Americanization Committee, at 18 West Thirty-fourth Street, New York City. The following paragraphs give the chief features:

Plans Desired

The competition has two broad divisions: the design of workmen's houses, and the design of substitutes for derailed box cars, commonly used to house construction gangs on railways.

The first division includes the following house plans:

1-A: House for single family, with two bedrooms.

1-B: House for single family, with three bedrooms.

2. House for family with four lodgers. Accommodations for lodgers to be entirely separate from those of the family, except as to the dining room.

3. Boarding house for thirty single lodgers.

Details as to the conditions governing the design of substitutes for the freight car are not yet available.

General Conditions and Prizes

In the housing competition, the buildings are to be suitable for industrial communities not exceeding 35,000 in population. The density to be provided is that of sixty-five people to the net acre. Two persons are allowed to each sleeping room.

Competitors are invited to include, in their specifications, methods of construction adapted to the plans which they submit. The merits of these suggested methods and materials will be considered by the jury in making the awards.

The committee has found it desirable to change the prizes from the amounts announced in the Engineering Record last week. The total of the awards, however, will be the same as before. For each of the four problems in the housing competition there will be a first prize of $300 and a second prize of $100. For excellence of construction there will be a single prize of $200.

The prizes in the competition for a substitute for the freight car total $600.

On the jury of awards is one engineer, Morris Knowles, of Pittsburgh. On the housing competition committee are the following engineers: Charles Whiting Baker, editor, *Engineering News;* E. L. Corthell, president, American Society of Civil Engineers; Gano Dunn, chairman, Engineering Foundation; Morris Knowles, consulting engineer, Pittsburgh; E. J. Mehren, editor, Engineering Record; Calvin W. Rice, secretary, American Society of Mechanical Engineers; William J. Wilgus, consulting engineer, New York.

Course in Proper Uses of Lumber at State College of Washington

A course of instruction in the proper uses of lumber is being offered by the State College of Washington, Pullman, Wash. Many of the colleges and universities have included this course in the regular curriculum, Syracuse University being one of the latest to take the step. The first courses of this nature were given in Wisconsin, where the state university extension division has also offered a course in Milwaukee for practical men. The Wisconsin lectures are given by a member of the forest products laboratory, maintained by the federal government, but the work is sponsored by the University of Wisconsin. The Milwaukee class numbers 63 members, representing 30 corporations, many of the students being in the class on office time. The course in Wisconsin covers such subjects as the structure and identification of wood, seasoning methods of wood preservation and fire retardants. The course also specifies why certain woods are best fitted for special uses. The Washington course provides extensive work based on a specially prepared textbook, in 10 assignments, as follows: "The Structure of Wood"; "Physical Properties of Wood"; "Standard Grades and Sizes"; "Structural Timbers"; "Seasoning and Preservation of Wood"; "Paints and Stains"; "Lumber Prices"; "Cost of Wood Construction"; "Specific Uses of Woods," and "Selection of Materials."

News of Engineering Societies

The Engineers' Club of Kansas City held a smoker last evening at which an effort was made to formulate plans for a good road campaign.

The Springfield Engineers' Club held a meeting March 13 at which the proposed bond issue of $1,500,000 for improving roads in Sangamon County was the subject of discussion.

The Manitoba Branch of the Canadian Society of Civil Engineers will hold a meeting at Winnipeg April 6, when M. C. Henry will present a paper entitled "Prairie Stream Discharge."

The Engineers' Club of Philadelphia has arranged for a series of lectures on military engineering to be delivered by Col. George A. Zinn, Corps of Engineers, U. S. A., April 1, 8, 15 and 29.

The Sociedad Cubana de Ingenieros will hear Jorge Brödermann speak on "Construction of a Railroad Between the Keys in the Bay of Caibarien" at the April meeting of the society, to be held at 76 Marti, Havana, Cuba.

The American Society of Civil Engineers will meet April 5 in New York City to discuss a paper by A. C. Janni entitled "Method of Designing a Rectangular Reinforced Concrete Flat Slab, Each Side of Which Rests on Either Rigid or Yielding Supports."

The Utah Society of Engineers has added sixteen new members to its list in the last few weeks. At a meeting held March 17, A. C. Watts read a paper entitled "Safety First in Coal Mines" and L. E. Abbott of the Oregon Short Line also spoke.

The Engineers' and Architects' Association of Southern California held a meeting in Los Angeles, March 17. G. A. Reichard, who recently returned from a business trip to Japan, gave an illustrated talk on China, Japan and the Philippines. Kiyo Sue Inui, a debater and lecturer, spoke on "America vs. Japan."

The Engineers' Club of Seattle heard N. A. Bowers, Pacific Coast editor of the Engineering Record, speak on "Co-operation Among Engineers," at a luncheon held March 16. W. T. Batcheller, assistant engineer in the city light department of Seattle, spoke on "Engineering Features Entailed in Construction of the Lake Union Steam Auxiliary Power Plant."

The Montana Society of Engineers has issued the first number of a publication to be called the Quarterly Journal of the Montana Society of Engineers. The object of the publishing committee will be to keep a printed history of engineering enterprises conducted by the members of the society and to further the interests of all members in every possible way. The headquarters of the society are in Butte.

The Engineers' Club of Kansas City recently held its annual dinner at which Major S. A. Cheney, Corps of Engineers, U. S. A., who is in charge of the Engineers' School at Fort Leavenworth, Kan., told of the manifold duties of engineers in time of war. He described a trip in an aeroplane over the entire length of a division whose men, horses, guns, equipment, ammunition train, supply trains, pontoon trains, engineers corps, hospital corps, etc., occupied about 25 miles of road.

The Engineers' Society of Pennsylvania, which now has over 700 members, will hold its annual banquet at the Harrisburg, Pa., this evening. Henderson Gilbert of Harrisburg will be toastmaster and the principal speakers will be A. T. Dice, the new president of the Philadelphia & Reading, Frederick W. Fleitz, former deputy attorney general of Pennsylvania, Colonel Biddle, Corps of Engineers, U. S. A., J. V. W. Reynders of Steelton, and Quincy Bent, general manager of the Pennsylvania Steel Company at Steelton, Pa.

Personal Notes

ALBERT A. NORTHROP, formerly of the firm of Seabury & Northrop, 101 Park Avenue, New York City, sails April 1 for Montevideo, Uruguay, where he will be connected with the construction of sewage disposal and water supply systems for various cities in that country. His headquarters will be at Montevideo.

CHARLES E. HEWES has been appointed city manager and city engineer of Alhambra, Cal. The two offices were recently combined and Mr. Hewes will have the supervision of all branches of the city government, including the street, building inspectors', plumbing and electrical inspectors' and police departments, and the city treasurer's office. He will also do the purchasing for all departments. It is believed that under the new arrangement the city government will be operated on a more efficient and economical basis.

Thomas A. Shepperd, vice-president of the T. A. Gillespie Company, whose appointment as general manager for the Ulen Contracting Company, on its $5,500,000 waterworks and sewerage systems contract in Uruguay is noted elsewhere in these pages, first engaged in engineering work in 1900 with the Denver Union Water Company. Since then he has been on railway irrigation, municipal and hydraulic work in this country, Alaska and Mexico. He was in the latter country for five years, and, as a member of the contracting firm of McQuatters & Shepperd, completed work there to a value of $1,000,000. As engineer of the Board of Public Works of the State of Chihuahua, he had charge of the design and construction of public works to a value of $3,000,000.

N. E. Hawkins will leave his position as chief engineer of the department of waterworks of Youngstown, Ohio, to become chief engineer for the W. M. Henderson Construction Company of Youngstown, April 1. After being graduated from the engineering department of the Ohio State University in 1907, Mr. Hawkins became assistant engineer with E. G. Bradbury, consulting engineer, of Columbus, Ohio, which position he held for two years. Sandusky, Ohio, claimed him as assistant city engineer for three years, after which he accepted the position of assistant city engineer of Youngstown. Mr. Hawkins' present work includes the design and construction of a new $650,000, 30,000,000-gal. filtration plant for the city of Youngstown.

Tribus & Massa, consulting engineers, 86 Warren Street, New York City, for 19 years consulting engineer for the borough of Chatham, N. J., has been re-engaged to continue the work the firm has been handling.

Charles S. Carroll has resigned from the civil engineering faculty of Ohio State University to become associated with the Ferro Concrete Construction Company of Cincinnati, Ohio.

S. G. Swigart will leave the U. S. Reclamation service to engage in civil and hydraulic consulting engineering practice in Missoula, Mont., April 1. He has just completed four years of service as irrigation manager of the Flathead project, and previous to that was engaged in civil engineering work in Colorado. Mr. Swigart's experience during the past nine years has been in the design and construction of important irrigation structures, preceding which he practised civil engineering in Akron, Ohio, and spent several years on railroad location and construction.

Webster L. Benham, chief engineer and manager of the Benham Engineering Company of Oklahoma, Okla., has become city engineer of Blackwell, Okla. Mr. Benham is a graduate of the engineering department of Columbia University and his engineering experience covers a period of nine years, during which he has been engaged in the construction of buildings, making of special surveys and has done a great deal of sanitary engineering work. He has been engaged in consulting engineering practice in Oklahoma since 1913, during which time he has personally designed and had charge of a large amount of work.

Howard W. Holmes has left his position in the bureau of highways and bridges of the department of public works of Oregon to open an office in the Northwestern Bank Buildin, Seattle, Wash., where he will practice as a consulting engineer.

George A. Johnson, consulting engineer and sanitary expert, 150 Nassau Street, New York, has been engaged by the borough of Matawan, N. J., to prepare plans and specifications for a sewerage system and sewage disposal works, and supervise the construction thereof.

Earl A. Zeisloft has been appointed city engineer of Akron, Ohio, succeeding J. E. Gehres, resigned.

James G. Griffiths, formerly superintendent of the Alleghany Light Company of New Kingston, Pa., is now connected with the Tri-cities Water Company at Monessen, Pa.

George W. Gardner, whose appointment as borough engineer of Madison, N. J., was recently announced in these columns, has been appointed engineer for the Township of Chatham. The new work will be in addition to his duties at Madison, and as consulting engineer for other towns.

Wilbur T. Mills Company has been incorporated to conduct an architects' and engineers' office in Columbus, Ohio. The officers of the company are: President, Wilbur T. Mills; vice-president, Edwin Rossbach, and secretary-treasurer, M. Lawrence Millspaugh.

K. A. Sinclair, formerly engineer on the Columbia Highway in Oregon, has been appointed Douglas County road superintendent, with offices at Roseburg.

H. Jay Hoffert, construction engineer with the Bell Telephone Company at Harrisburg, Pa., has resigned to become sales agent for the International Correspondence Schools. Mr. Hoffert is a graduate of Cornell University.

Samuel B. Fisher, formerly chairman of the valuation committee of the Missouri, Kansas & Texas Railway has been appointed consulting engineer of that road.

Gordon C. Douglas has been appointed city engineer of Covina, Cal. Mr. Douglas was for several years with the U. S. Geological Survey, working in the California branch as a topographer and surveyor.

Joseph P. Bayne, after thirty-one years of continuous service with the city of Cleveland, Ohio, has resigned to accept the position of engineer of paving for the Cleveland Railway Company. Mr. Bayne assumed his new position March 1.

G. C. Willson, formerly principal assistant engineer in charge of the construction of what is said to be the largest fuming sulphuric acid plant in the world for E. I. du Pont de Nemours & Company at Hopewell, Va., has completed his work there and is now building a similar plant for the Hercules Powder Company at Kenil, N. J.

A. A. Baker, formerly engineer-draftsman for the Pennsylvania Steel Company at Steelton, Pa., has resigned to become superintendent of construction for the Henry Kopperas Company, coke oven builders, of Pittsburgh.

William R. Roy, Washington State highway commissioner since 1913, has resigned his position on account of ill health. His resignation will be effective as soon as a new commissioner can be appointed.

Joseph B. Baker has been promoted from assistant supervisor for the Pennsylvania Railroad System at Newport, Pa., to supervisor in the office of the assistant to the general manager. Mr. Baker was graduated from the University of Pennsylvania in 1905 and entered the service of the Pennsylvania on July 1 of that year as rodman in the construction department. He was made transitman at Altoona, Pa., in 1905 and was advanced to assistant supervisor.

Crowell M. Dennis, formerly transitman in the office of the engineer of maintenance-of-way of the Pennsylvania, is now assistant supervisor on the Cresson Division of that road. Mr. Dennis was graduated from the civil engineering department of Princeton University in 1909. He entered the service of the Pennsylvania Railroad in June, 1910, as rodman on the Baltimore division and in 1915 he was appointed transitman in the office of the engineer of maintenance-of-way at Philadelphia.

William H. Becker has severed his connection with the Arizona Eastern Railroad to act as consulting engineer for the Gila County Road Department, with headquarters at Globe, Ariz. Mr. Becker will handle the road work that is being done under a $3,500,000 bond issue.

C. H. Johnson has resigned from the position of engineer of construction for the Nashville, Chattanooga & St. Louis Railway to accept an appointment as superintendent for the Gould Contracting Company of Nashville.

W. B. Lewis, who was recently engaged in making surveys and investigating the industrial possibilities of nothern Patagonia for the Argentine government, is now superintendent of Yosemite National Park, California.

George N. Adams has been appointed city engineer of Tropico, Cal. Mr. Adams has been engaged in engineering work in California since 1905. He was recently chief of party for the Imperial District, making topographical and canal location surveys.

Otis A. Barge, after two years as superintendent of construction for Albert Kahn, architect, of Detroit, has become associated with Allen J. Krebs, general contractor, of Birmingham, Ala., and will have charge of the new office of that concern at Atlanta, Ga.

C. D. Conway has returned to his position as superintendent for the Los Molinos Land Company, Los Molinos, Cal. He will begin the preparation of ditches for the 1916 irrigation season, which begins April 1. Aside from cleaning and repairing the ditches, a number of wooden flumes are to be replaced with steel ones and the ditch along the west bank of Antelope creek is being replaced by concrete. Mr. Conway was engaged in the building of reinforced-concrete bridges in California previous to accepting his present position.

Henry E. Elrod of Dallas, Tex., has been retained by the city of Coleman to design and supervise the construction of a reinforced-concrete reservoir.

Agnew T. Dice, formerly vice-president and general manager of the Philadelphia & Reading Railway, was appointed president of that road March 15 to succeed the late Theodore Voorhees. He entered railway service in 1881 in the engineering department of the Pennsylvania, and a year later was appointed superintendent of signals for the New York Central & Hudson River Railroad, which position he held until his appointment as superintendent of the Atlantic City Railroad in 1894. He was made assistant superintendent of the Reading division of the Philadelphia & Reading in January, 1896, and a month later was appointed superintendent of the Shamokin division. He was promoted to general superintendent in 1903 and in 1910 was made general manager. Mr. Dice was appointed a vice-president in 1913.

C. P. Bowie is no longer engineer of the Associated Pipe Line Company of San Francisco. He left that position to become petroleum engineer for the U. S. Bureau of Mines, with headquarters in San Francisco.

Frank P. McKibben, professor of civil engineering at Lehigh University, has been elected vice-president of the People's Trust Company, South Bethlehem, Pa. He will continue his services as professor of civil engineering.

W. P. Chapman, formerly highway engineer for Olmstead County, Minn., with headquarters at Rochester, is now superintendent of roads for Rice County, with headquarters at Faribault, Minn.

Gilbert K. Cooper has resigned his position as chief engineer of the United Fruit Company, Costa Rica Division, to accept an appointment as inspector with the Chicago Union Station Company.

C. B. Lamont, manager and consulting engineer for the Skinner & Eddy Corporation, Seattle's newest shipbuilding concern, has opened private offices in the Hope Building. He will continue to act as consulting engineer for the Skinner & Eddy Corporation, and, in addition, will conduct a consulting engineering practice. Mr. Lamont was graduated from Cornell University in 1900 and has been engaged in work on the Pacific Coast ever since.

Karl F. Keeler of Provo, Utah, has been appointed engineer of the new high line of the government's Strawberry Valley project.

Richard H. Jamison has been appointed city engineer for Alameda, Cal. He is a graduate of the University of Pennsylvania and has been a resident of California for about 15 months.

R. Boone Abbott, formerly division engineer of the Philadelphia & Reading, with headquarters at Harrisburg, Pa., has been appointed superintendent of the Shamokin division of that road, with headquarters at Tamaqua, Pa. Mr. Abbott studied engineering while a draughtsman in the office of the division engineer at Reading. He was born in Philadelphia and entered the employ of the Reading in 1900; in 1905 he was made assistant engineer at Reading, and later in that year became assistant supervisor at Harrisburg. In March, 1906, Mr. Abbott was transferred to the New York Division, with headquarters at Philadelphia, where he remained until April, 1909, when he was transferred to Pottsville. He became division engineer of the Harrisburg division in March, 1910.

C. H. Ewing has been promoted from general superintendent of the Philadelphia & Reading to succeed A. T. Dice as general manager of that road. Mr. Ewing came to the Reading as rodman in the construction department and at the age of twenty he was assistant engineer of construction. His rise was rapid and in 1893 he became chief engineer of the Central New England Railway. He returned to the Reading in 1902 and in 1913 became general superintendent of the system.

J. E. Turk has been appointed general superintendent of the Philadelphia & Reading, succeeding C. H. Ewing. Mr. Turk came to the Reading in 1889 as superintendent of the Reading division and in 1903 was made superintendent of the Shamokin division, which position he held until his new appointment.

George E. Scarfe, who has been superintendent of electric power and water in the Grass Valley-Nevada City (Cal.) district of the Pacific Gas & Electric Company for many years, has tendered his resignation to take effect March 31. Mr. Scarfe is leaving the company to take up consulting engineering, specializing in mechanics, electricity and hydraulics.

W. G. Turner of Fort Worth has been elected president of the Texas State Good Road Association for the ensuing year.

James Allen, former chief engineer of the Washington State Highway Commission, has been appointed state highway commissioner to succeed William R. Roy. Mr. Allen immediately announced the appointment of George F. Cotterill, former Mayor of Seattle, as chief engineer of the commission. The appointment of Messrs. Allen and Cotterill became effective March 20. James Allen came to the state highway board in 1909 as locating engineering under J. M. Snow and was made chief engineer in December, 1913. Prior to joining the highway board staff, Mr. Allen had a wide experience in civil engineering on railroad construction.

J. W. Sadler, an inspector in the department of public works of Portland, Ore., and recently identified with the Oregon State Highway Department, has been named as consulting engineer for the department of public works of Portland. The appointment has been ratified by the city council.

E. M. Carter, city engineer for Ellensburg, Wash., resigned from his position March 15. It is said that he will engage in the general contracting business in California.

Roy Greene, deputy county engineer of Lewis County, Wash., has resigned his position and moved to Minneapolis, Minn.

Paul Hansen, acting chief engineer for the Illinois State Board of Health, has been made chief engineer, his appointment being confirmed recently by the Civil Service Commission. He leaves vacant the position of chief engineer to the State Water Survey, of which Prof. Edward Bartow is director.

George W. Myers, who has had charge of concrete highway promotion and construction for the Portland Cement Association, has been promoted to a position in the association's Chicago office, where he has charge of concrete highway promotion in the entire United States.

H. D. Cromwell has resigned from his position as engineer on the construction of the Fairchild Street subway in Danville, Ill., to become engineer for the Beaver Electric Construction Company of Chicago.

Obituary Notes

Frederich A. Reily superintendent of the Waterbury Gas Works, Waterbury, Conn., died March 6, at the age of twenty-seven. Mr. Reily was a graduate of the engineering department of Cornell and his death is attributed to an injury he received while playing football while attending the university.

P. T. Walsh of the Walsh Construction Company, Chicago, and Davenport, Iowa, died in the latter city, March 16, at the age of 62. He was one of the well-known early railroad contractors.

Erasmus Darwin Leavitt, of Cambridge, Mass., a man who had occupied a prominent place in the engineering profession, died March 11. He was born in 1836, and, at the age of 16, began work in the shops of the Lowell Manufacturing Company, where he served as apprentice for three years. He spent a year with the Corliss & Nightingale Company and was later assistant foreman of the City Point Works in South Boston. He was with Thurston, Gardiner & Company of Providence, R. I., from 1859 to 1861, and from the latter date until 1867 he was assistant engineer in the U. S. Navy. He was consulting engineer for the Calumet & Hecla Mining Company from 1874 to 1904, the time of his retirement. He was also consulting engineer for Henry R. Worthington of New York, the Dickson Manufacturing Company, the city of Boston, and designed the pumping machinery for the city of Louisville, Ky. As advisory engineer he designed machinery for the Bethlehem Steel Company and for South African Mining Companies. Mr. Leavitt was a member and past-president of the American Society of Mechanical Engineers, the American Society of Civil Engineers—which he joined in 1873—the American Institute of Mining Engineers, the Boston Society of Civil Engineers, the American Society of Naval Engineers, an honorary member of the British Society for the Advancement of Science, life member of Franklin Institute and member of Institution of Civil Engineers and of the Institution of Mechanical Engineers of Great Britain. He was also a fellow of the American Academy of Arts and Sciences. In 1884 Mr. Leavitt received the honorary degree of Doctor of Engineering from Stevens Institute of Technology.

John W. Braid, for twenty-six years with the George A. Fuller Construction Company, died in New York City on March 14. Mr. Braid had charge of the construction of many important buildings, including the Pennsylvania Railroad terminal, in New York City, and in Columbus, Ohio. He came to the United States from Scotland while a young man and took up work in Chicago. Soon after he became associated with the George A. Fuller Company, later rising to the position of superintendent, which he held at the time of his death.

Frederick N. Finney, former president of the Missouri, Kansas & Texas Railroad, died March 18 in San Francisco. He entered the engineering department of the Cincinnati, Harrison & Indianapolis Short Line in 1854, and, later, was connected with several roads in the Middle West. In 1867 he had risen to the position of resident engineer for the Erie & Pittsburgh Railway and in 1868 he was promoted to the grade of general superintendent and chief engineer. He took a similar position with the Canada Southern in 1870 and served with that road for three years, after which he spent a few years with different roads, and from July, 1878, to October, 1886, he was general manager of the Wisconsin Central Associated Lines, being promoted to grade of managing director on the latter date. In 1887 he left the Wisconsin Central and in June, 1890, again took up work as president of the Soo Line and second vice-president of the Duluth, South Shore & Atlantic. In 1894 he accepted a position as superintendent of construction, and director and member of the executive committee of the Missouri, Kansas & Texas and in 1904 was elected president. He resigned that position Dec. 1, 1906.

Lightner Henderson, for many years chief engineer of the firm of Purdy & Henderson, died in Chicago, March 16. He was born in 1866 at Gap, Pa., and was graduated from Lehigh University in 1899. He supervised the construction of a large number of buildings, including the Flatiron in New York City, the New York Times and Municipal buildings, the Metropolitan Life Insurance Tower and the Waldorf-Astoria Hotel, and the North American Building, the Cook County court house and the City Hall, of Chicago. He also did considerable work in Cuba and Canada. He was a member of the Western Society of Engineers, the Chicago Engineers' Club and the Franklin Institute of Philadelphia.

Louis P. Morehouse, who retired from active service with the Illinois Central Railroad in 1905, died in Los Angeles, Cal., March 18. He was born March 30, 1835, in New Haven, Conn., and after graduation from Yale in 1856 he was engaged on the preliminary survey of the New London & Stonington Railroad as rodman. In May, 1857, he was employed by the Illinois Central Railroad as assistant to the division engineer and continued in the engineering department of that road for twenty years, being promoted during that time to the position of assistant chief engineer. In 1877, in the "interests of economy," the engineering department was abolished and for a year thereafter Mr. Morehouse was in the office of the president and of the general auditor. From 1878 to 1887 he was tax agent and land commissioner and tax agent from 1887 to 1890. At the time of his retirement, in 1905, he was custodian of deeds. He was one of the original members of the Western Society of Engineers, being secretary of that organization from 1869 until 1887.

Charles J. H. Woodbury, consulting engineer, of Boston, died at his home in Lynn, Mass., March 20, at the age of 64. Dr. Woodbury was graduated from the Massachusetts Institute of Technology in 1873 and later spent several years in the engineering department of the American Bell Telephone Company. In 1908 he opened offices as consulting engineer in Boston and devoted much of his time to writing articles of a technical nature. He was a member of many engineering and historical societies and considered an expert on telephone engineering.